Comment/Responses
PPL Montana Colstrip Steam Electric Station
Administrative Order on Consent Plant Site Report

(Plant Site Characterization Report)

Conditional Acceptance by Montana Department of Environmental Quality
September 5, 2014

DEQ conditionally approves the Plant Site Report provided the following revisions to the report are made to satisfaction of DEQ.

Pursuant to the Administrative Order on Consent (AOC) between the Montana Department of Environmental Quality and PPL Montana (PPLM), PPLM is required to provide, at a minimum, specific information in each of the site characterization reports (pages 17-19 of the AOC).

DEQ affirms that PPLM has provided information concerning the topics listed in the AOC. These topics and their location in the Plant Site Characterization Report are listed below:

1. Identification of releases, if any, for each area and the sources of the releases (Section 3.1, pages 3-1 and 3-2).
2. A description of the investigations performed to date, including a list of reports resulting from the investigations and a summary of the findings and results from the investigations (Section 3.2, Table 3-1, pages 3-3 to 3-23 inclusive.)
3. Water models and results of modeling (Plant Site Groundwater Model Redesign and Calibration Colstrip Steam Electric Station, December 2012).
4. Information concerning remedial actions
   a. A description of completed and ongoing remedial actions (Section 3.5, pages 3-38 to 3-48 inclusive).
   b. Sampling parameters and frequency of any ongoing monitoring for remedial actions (Section 3.5.1, pages 3-38 to 3-40 inclusive).
   c. An effectiveness assessment of the remedial actions (Section 3.6, pages 3-48 to 3-59 inclusive).
5. A description of the construction of each pond and pond contents through time (Section 2.2 pages 2-2, 2-3, 2-4, and 2-5, including Table 2-1).
6. An estimate of the seepage to ground water beneath each pond. (Section 2.3, pages 2-5, 2-33, and 2-34).
7. Identification of data gaps. (Section 5.0, pages 5-1 and 5-2).
8. Recommendations for additional site characterizations. (Section 6.0, pages 6-1 and 6-2).

DEQ notes that in the conditional approval, DEQ is requesting more information concerning the majority of these topics.

Comment:

Note 1: The revisions requested by DEQ were developed by DEQ staff with the assistance of an external contractor. DEQ accepted the final set of comments by the contractor.

Comment:

Note 2: DEQ requests that at each occurrence in the Plant Site Report or the Plant Site Groundwater Model Report of the reference to or use of the background screening levels (BSLs) of the indicator parameters, PPLM note in the text or in a footnote on the same page that the BSLs are under review as of July 2014.

Response to Comment Note 2 on previous page: PPL acknowledges that the BSL's are under review and will acknowledge that in the revised report. Note, however, that the date will used will be October 2014 to be consistent with the date provided in the groundwater model report comments from MDEQ.

Comment:

Note 3: The comments in this document concerning tables uses the original numbering scheme in the Plant Site Report. Additional tables are requested. After addition of tables, please renumber all tables. Please update references in the text to the tables.

Response: The report will be updated to reflect changes in table numbers

Comment:

I. **Outlined Revisions Requested by DEQ**

Prior to Section 1.0, DEQ requests that an executive summary be added that provides a concise description of the major information set forth in the Plant Site Report that is understandable by the general public.

A. Section 1.0 Introduction

No changes

Response: An Executive Summary will be added to the revised document.

B. Section 2.0 Pond Construction and Closed Loop Description

1. Section 2.1 Closed Loop System

DEQ requests that PPLM specify what is being transported between the power units, the scrubbers and the ponds. Please move the description from Section 2.2 to Section 2.1.

DEQ requests that PPLM add a general discussion of the circulation of water and water-suspended ash within the Plant Site Area that will complement and extend the explanations located in Table 2-1. DEQ requests that a new figure be added showing the circulation patterns between the Plant Site Area ponds and Units 1-4.

As part of this subsection, DEQ requests that PPLM discuss the problems of measuring the piped flow rate between components within the system using in-line flow meters, including the issue of scaling. DEQ defines the "system" flows as including all the piped flows from the plant to the ponds (containing ash), the return flows from the ponds to the plant (containing clear water), and the piped

flow of water from capture wells and pond drains. DEQ requests that PPLM acknowledge that some of the current flow rates are not being measured, some of the flow rates are measured (possibly with correction), and some of the flow rates are estimated.

Response: A detailed diagram of the process water circuit at the Plant Site has been added to the report that illustrates routing between various active ponds at the facility. A general discussion of flow patterns of water containing fly ash and clear water has been added to the report.

A discussion of difficulties measuring flows within the process water circuit, including groundwater capture wells has been added to the text. As such, PPL has acknowledged that some flow is not being measured, some of the flows are measured, and some are estimated.

Comment:

2. **Section 2.2 Plant Site Ponds**

DEQ specifically requests that PPLM discuss the importance of pond water management and what PPLM does to minimize water in the ponds.

In the original report, the plant site features were identified using inconsistent naming conventions. PPLM has supplied a table listing all naming conventions as a result of Comment #1 by the contractor; in the response by PPLM to comments from the contractor this table is titled "Comment #1 Response Table". DEQ requests that the table be included into the site characterization report and that consistently named conventions are used throughout the document.

Please define the terms "blowdown," "scrubber", "wash tray", "leachate collection system", "RFP," "HDPE," "Hypalon".

Response: A discussion of the pond water management, including measures taken to reduce the amount of water maintained at the site, has been added. The table included in the response to Hydrosolutions Comment #1 has been integrated into the report – as Table 2-2. Table 2-2, from the December 2012 submittal of the report, will be Table 2-3 in the next submittal.

Comment:

i. **Section 2.2.1 Plant Site Pond Water Quality**

1. **DEQ requests in Section 2.2.1 that PPLM explain if the reported pH and specific conductance values in Table 2-2 are field measurements or laboratory measurements. Please also explain this in a note below the title of the table and before the body of the table containing the data.**

Response: A reference to the field or laboratory analysis will be added to the table. Note that all data in this table are based of laboratory analyses. Also note that with previous requested changes Table 2-2 is discussed in Section 2.2.2.

Comment:

2. **DEQ requests that PPLM provide the typical pond sampling rate for each pond as well as the routine sampling parameter list for each pond in an added table to Section 2.2. DEQ also requests a list of special sampling events added to Section 2.1.1 that describes sampling which has been done in the ponds as a result of special events such as accidents or spills. Please include dates of sampling and the sample parameters.**

Response: Sampling conducted as a result of specific releases is provided in various previous site reports, if conducted. This information is not tracked in the project database. Note that pond quality sampling is rarely conducted in association with pond investigations since the general pond chemistry is well understood. For this reason, a table summarizing "special sampling events" has not been added to the report. Please refer to the text in Section 2.2.2 and comment response 12 for Section 2.2.1 regarding special sampling events for the ponds.

Select ponds, as listed in the project monitoring plan, are sampled at a minimum frequency of once every three years. Parameters may vary but at a minimum are analyzed consistent with PPLM's normal analytical parameters. Expanded analyses are periodically conducted on selected ponds. Such sampling was requested at the request of MDEQ and was conducted in December 2002 A description of this sampling will be added to the text in Section 2.2.2 (following previous text revisions).

PPLM sampled six select ponds in December 2002 and analyzed the samples for an extended suite of inorganic and organic parameters. PPL conducted a similar sampling event in July 2012. Both sampling events targeted ponds that would be most likely to accidently receive organic or inorganic parameters.

PPL has also conducted sampling in response to releases, or suspected releases that may have resulted in introduction of site chemicals into the ponds, specifically petroleum hydrocarbons. In the event of site spill, an upset of containment facilities, or observations by site personnel, samples for analysis of petroleum hydrocarbons have been collected from a few ponds. These ponds and the analyses are included in Section 2.2. and analysis.

Comment:

3. **DEQ requests that as a supplement to the site report, the full set of pond water quality data for all ponds sampled in the Plant Site Area be presented to DEQ either as a series of spreadsheets (one per pond) or in a database.**

Response: These data have previously been submitted to the MDEQ Major Facilities Siting program in electronic format requested by the department. A disk including Pond data in electronic format is included in an Access database format in Appendix B.

Comment:

4. **DEQ requests that PPLM prepare historical documentation concerning changes in the methods of analysis and detection limits for the chemical parameters sampled in the ponds and groundwater. For each chemical parameter sampled, please list the detection limit, reporting limit and the time period of validity of the two limits. DEQ requests that this document be included in the site characterization reports as an appendix. This document will be used to better interpret historical chemical trends.**

Response: An appendix with analytical methods and reporting limits is in Appendix . In additiona, portions of the information below have been added to the text of Section 2.2.2.3.

The laboratory reporting limit (RL) is defined as the lowest concentration at which an analyte can be detected and reported with a reasonable degree of accuracy and precision in a sample. The standard for this is the quality control (QC) criteria used by the laboratory for the method. The RL or method reporting limit (MRL) is often the concentration of the lowest standard on the calibration curve. Reporting limits may be raised if sample matrix interferences are present, and interferences are corrected for changes in sample's prep amount or extract/digestate dilutions.

During the progression of long-term data collection there have been many analytical method changes and improvements. The MRLs and RLs, have frequently changed over time, due to state and federal agency requirements. These changes have had substantial effects on trend analysis. Less accurate methods used in the past have produced a greater variance in the data. <u>The significance of this is an artificial trend.</u>

A thorough assessment of the multiple analytical method changes and multiple reporting limits should be made in order to avoid simply measuring changes in the monitoring program not the environment. A table showing historical reporting limits and recent method detection limits is included in Appendix F.

Comment:

5. **DEQ requests that documentation about pond sampling techniques be added to the text of Section 2.2.1. Specifically, DEQ requests information as to whether or not for each surface water data set, the location of sampling has remained the same or has been moved over time. Also, DEQ requests information as to the depth of water at which sampling occurred for each pond. Please explain if the depth of the water column is measured as part of the sampling protocol. Ideally, water quality sampling should be from the middle of the water column. Finally, please describe if weather information (such as wind speed and direction or occurrence of precipitation) is noted during sampling.**

Response: Text describing pond sampling techniques has been added to Section 2.2.2 (section number changed due to earlier requested revisions by MDEQ). Depth samples are not typically collected. To do so on most ponds would require personnel to use water craft to enter the deepest part of the ponds, measure depth at the time of sampling, and sample. Safety considerations outweigh the benefit from collecting samples using this methodology during the operational stage of monitoring. A more thorough evaluation of pond water chemistry may be warranted if the ponds are to be completely dewatered and the water treated during closure activities.

A set of depth samples were collected from the pump barge at the Stage II Evaporation Pond Clearwell (not on the Plant Site) in March 2007. A sample was also collected from near surface of the pond, next to the barge, at this time. TDS concentrations in the near surface samples were approximately 33% higher than samples collected at depth.

Weather conditions are typically not recorded during pond sampling events.

Comment:

6. **Standard water quality protocol is that surface water quality should be assessed using total recoverable (unfiltered) samples as well as dissolved (filtered) samples, particularly in environments where fine sediment is present such as in the Colstrip ponds. In Table 2-2, total recoverable concentrations for metals have not been reported for surface water samples taken at the following ponds: 1 & 2 AB Pond; 3 & 4 Bottom Ash Ponds; 1 & 2 Cooling Tower; 3 & 4 WTP; 1 & 2 PNDC N. The other ponds were sampled for both dissolved**

and total recoverable metal concentrations. DEQ requests that PPLM add information to Section 2.2.1 explaining why total recoverable samples were not collected at these listed ponds as well as documentation of any decisions made that historically established or modified which samples were taken in these ponds.

Response: Both dissolved and total recoverable phases were reported when available. The MDEQ approved site monitoring list specifies analysis by dissolved constituents. Text has been added to provide explanation of the rationale for sample filtration.

Comment:

7. **Comparing the ponds listed in Table2-1 with the data sets listed in Table 2-2, DEQ cannot find chemical profile data for the Units 1 & 2 Brine Waste Disposal Ponds (D1, D2, D3, and D4 Ponds), the Units 3 & 4 Auxiliary Scrubber Drain Pond, and the Units 3 & 4 Scrubber Drain Collection Pond (DC Pond). If the data for these ponds are located in Table 2-2, DEQ requests that PPLM label the data so the pond data can be easily identified. If the data exists but were not included in Table 2-2, DEQ requests that the data be added to Table 2-2. If the data do not exist, DEQ requests that PPLM explain why the ponds were not sampled.**

Response: Data for the Brine Ponds and the DC Pond were inadvertently omitted from the December 2012 submittal. Table 2-3(Formerly 2-2) will include the full set of data in the next submittal.

Brine pond samples represent samples collected from all of the cells of the Brine Ponds (D-1 through D-4). These data were originally maintained under the "brine ponds" designation and were not differentiated between cells.

There are no data for the Units 3&4 Auxiliary Scrubber Drain Pond.

Comment:

8. **Because of the likely presence of fine sediment in the surface water in the ponds, the chemical concentrations for a constituent in a total recoverable sample should be larger than the concentration for the same constituent in a dissolved sample if both samples are taken at the same location at the same time. Comparing total recoverable and dissolved values in the tables gives the impression that there are numerous cases where the total recoverable value appears less than or equal to the dissolved value. Examples of this are found in the minimum and maximum values of reported antimony, arsenic, barium,**

cadmium, copper, iron, lead, selenium, and zinc for the "1 & 2 B Pond Between Liner" data set. However, this apparent discrepancy may be an artifact of how the data were presented in a summary format. Resolution of this issue may result from analysis of the full pond water chemistry data already requested in the third point of this section of the comments. DEQ requests that PPLM explain in Section 2.2.1 if there is a case that for the same sample and the same constituent, the total recoverable concentration is equal to or less than the dissolved concentration.

Response: The variations identified are a function variability in the number of analysis for dissolved and total recoverable metals. In general, if there are no suspended particulates in an aqueous sample, and therefore the filtered and unfiltered concentrations for an analyte are equal, random error in the laboratory analytical procedure will result in approximately one half of the results for filtered samples being greater than that for the unfiltered samples. This is simply due to the acceptable +/- 20% percent variability in the laboratory results.

Note: PPLM has provided "full" data to MDEQ Major Facilities Program in the requested format in previous years. Data provided in the table represent all of the data availabl for these ponds.

Comment:

9. **DEQ requests that PPLM present in Section 2.2.1, in each pond, the concentration data for the indicator parameters (specific conductance, sulfate concentration, chloride concentration, and boron concentration), candidate indicator parameters (bromide concentration), major cations (calcium, magnesium, sodium, and potassium) as well as pH, TDS, total alkalinity as CaCO3, and bicarbonate concentration, in graphical form plotted versus time in order to document how the pond water has changed over long periods of time. DEQ requests that the concentrations be plotted from the date of first sampling following when the pond operations commenced to the present or the date when pond operations were significantly changed enough that surface water sampling ceased. DEQ requests that PPLM discuss the cause of the plotted changes in chemical concentration including changes caused by changes in plant operation, changes in water management pond procedures, or the effects of physical and chemical processes (such as evaporation) affecting the water in the ponds.**

Response: Water quality graphs and piper diagrams for the Plant Site ponds have been included as Appendix B. Text has been added to the report describing why the chemistry of process water ponds varies.

Comment:

10. **DEQ requests that PPLM plot the major cation/anion composition (Mg, Ca, Na, K, Cl, CO3, HCO3, SO4) of the samples for each pond using trilinear Piper diagrams. DEQ requests that in each Piper diagram the pond samples be labeled sequentially by number (e.g. the oldest sample would be labeled as "1").**

Response: Piper diagrams illustrating cation-anion distribution for Plant Site ponds are contained in Appendix A Plant Site Pond Graphs and Piper Diagrams. Note that in some cases water quality changes are minimal with time resulting in numerous points plotting on top of one another. The adjacent identifiers in this may also plot on top of one another and numbering may be unidentifiable.

Comment:

11. **In Table 2-2, the chemistry of nonsurface sampled water (from "1 & 2 B Pond Between Liner", "1 & 2 B Pond Underliner", and "Units 1 & 2 Bottom Ash Clearwell Underdrain") exhibits great variability with respect to specific conductance, major cations (calcium, magnesium, sodium, and potassium), and current and candidate indicator parameters (sulfate, chloride, boron, and bromide). In the context of the current data set, these samples are the best approximation to the chemistry of water leaking from the ponds into the subsurface. The chemistry of theses samples may be affected by several factors such as seasonal effects (e.g. precipitation or evaporation), plant and pond operations and changes to pond water and ash management, and ash heterogeneities and preferential flow paths for water in the pond ash. The chemistry could also be affected by the drain geometry, how leachate is collected in the drain system, and where and how sampling of the leachate occurs. Inferred high groundwater levels under 1 & 2 B Pond suggest that the data from the 1 & 2 B Pond are also impacted by mixing with groundwater. DEQ requests that PPLM explain in Section 2.2.1 the great variability of the chemistry.**

Response: It is correct that some of the water collected from the Units 1&2 B Pond Underdrain actually intercepts groundwater, as well as collecting water potentially from the ponds. These variations will be explained in more detail in the report in Section 2.2.2.

Comment:

12. **DEQ requests that PPLM explain in Section 2.2.1 the wide variation of the number of sampled parameters in the ponds as documented in Table 2-2.**
    a. **DEQ requests that PPLM explain why some ponds have been sampled for organic chemical/hydrocarbon parameters. These Ponds include: 1 & 2 Flyash A&B Pond Clearwell; 3 & 4 Bottom Ash Clearwell; 1 & 2 Pond A; 1 &**

2 Pond B; North Plant Area Drain Pond; North Plant Sediment Pond; Units 1-4 Sediment Pond; 1 & 2 PNDC. DEQ recognizes that sampling for these parameters may have been as a result of releases in or around these ponds. If releases are the cause, please synopsize the releases citing available documentation that is presumably listed in Table 3-1. If releases are not the cause, please explain the reasons for the sampling.

b. **DEQ requests that PPLM explain why some ponds appear to be sampled for few parameters compared to others. DEQ recognizes that this may be because of changes in number of parameters sampled with time or the role of the pond and the pond water in the plant processes. These ponds and structures include: 1 & 2 B Pond Underliner; 1 & 2 Bottom Ash Underliner; 1 & 2 Bottom Ash Pond; 1 & 2 AB Pond (compared to 1 & 2 Pond-A and 1 & 2 Pond-B); 1 & 2 PNDC N (compared to 1 & 2 PNDC). Please explain why the sampling for the 3 & 4 Bottom Ash Pond (data sets 3 & 4 Bottom Ash Clearwell and 3 & 4 Bottom Ash Pond) is more extensive than the data sets for the 1 & 2 Bottom Ash Pond.**

Response (a): These two Sampling and expansive analytical events were not done as the result of releases around pond.

Process pond water sampling was conducted at the PPL Montana, LLC (PPL) Colstrip Steam Electric Station in response to a request by the Montana Department of Environmental Quality (MDEQ) Major Facilities Siting Program in a letter to PPL Montana, LLC (PPLM), dated October 29, 2002. A full suite of analytical parameters were analyzed which included inorganic and organic parameters. Ponds chosen to be sampled were the ones that were most likely to contain the constituents to be analyzed, due routing of the process waters.

PPLM voluntarily conducted additional pond sampling for extended parameters in December 2012 for a suite of parameters similar to those analyzed in 2003. This sampling was conducted voluntarily by PPL as a to provide a thorough check of pond chemical constituents.

Response (b): Sampling frequencies and parameters lists have changed with time. Some ponds may also have been sampled in association with other investigations or operational activities at the site. The result is a difference in the number of samples and parameters analyzed.

Comment:

13. **PPLM is considering using bromide as an indicator parameter in groundwater sampling (Section 3.4.2, page 3-27). Bromide was recently introduced (2007?) into the plant processes. Bromide concentrations vary widely within the pond chemical profiles. Minimum and maximum concentrations of bromide in the**

ponds include: 12-218 mg/l (1 & 2 Pond-B); 10-10 mg/l (1 & 2 B Pond Underliner); 5-29 mg/l (1 & 2 Bottom Ash Clearwell); 20-76 mg/l (1 & 2 Bottom Ash Clearwell Underdrain); 5-5 mg/l (1 & 2 Bottom Ash Pond); 2-2 mg/l (1& 2 Flyash A and B Pond Clearwell); 0.5-21 mg/l (3 & 4 Bottom Ash Clearwell); 5-5 mg/l (Bottom Ash Pond); 1-2 mg/l (North Plant Area Drain Pond); 0.5-0.65 mg/l (North Plant Sediment Pond). DEQ requests that PPLM discuss in Section 2.1.1 the distribution of bromide concentration ranges in the ponds and explain the causes of the variability in concentration. Further comments concerning bromide are located in the comments concerning Section 3.4.2.

Response: Text has been added to section 2.2.2(new section number resulting from previous revisions) regarding bromide concentration variation. Variations in bromide concentrations are a function of the process water streams, variations in the amount of dilution or concentration through precipitation and evaporation. Calcium bromide is added to the scrubber as part of the mercury removal process. For this reason, ponds that are more directly connected to the scrubbers will have higher bromide concentrations. The amount of inventory in a pond will also have an affect on the concentrations of bromide in the ponds. Higher concentrations will result with more evaporation. Conversely, lower concentrations result from periods of high precipitation or if a substantial amount of raw water is added to the system.

Comment:

14. **DEQ requests that PPLM clarify the reasons why total recoverable (unfiltered) samples were taken as part of the 1 & 2 Pond Between Liner data but not as part of the 1 & 2 Pond Underliner data set. The 1 & 2 Pond Between Liner data show apparently significant large total recoverable concentrations of boron and manganese that are different from the dissolved concentrations. At lower concentration levels, the same pattern appears to be true for manganese and nickel. DEQ recognizes that the issue may be resolved once DEQ has the entire chemical data set for the ponds.**

Response: Please note that PPLM has provided all pond water quality data to MDEQ Major Facility Siting Program.

Only one duplicate sample from the Units 1&2 B Pond Between Liner has been analyzed for both total and dissolved phases. This sample was also analyzed for an extended suite of metals using two different analytical methods (6020 & 200.8). This sample was not collected in response to a specific release.

During routine operational monitoring, water from the Units 1&2 Pond between liner and Units 1&2 Pond underliner is typically analyzed for dissolved boron and selenium using method 200.8.

These requests by DEQ are the response to Comment #2 by the contractor, "Hydrosolutions", hired by DEQ to evaluate the Plant Site Report.

Comment:

ii. Section 2.3 Pond Seepage Estimates

DEQ recognizes that the pond seepage calculations are based on estimates of parameters and conditions in the ponds, in the liners, and below the liners. DEQ cannot verify the accuracy of the pond seepage estimates stated in the Plant Area Site Report. DEQ does concur that PPLM satisfied the AOC by providing pond leakage estimates.

The DEQ requests for changes to Section 2.3 are based on responses to Comments #3-8 by the contractor.

Comment 3. Section 2.3. First Sentence. Please identify each pond listed on Table 2-1 that was used in the seepage estimates in the Plant Site Report. Please provide all input parameters for each pond used to calculate seepage, and the estimated results. Currently, there is insufficient information to review the calculations and results provided.

Response:

Ponds used in Seepage calculations are identified in Table 2-4 of the revised Section 2.3 and include:
Units 1&2 Flyash Pond A, B, Clearwell
Cooling Tower Blowdown Pond C (north and south).
Units 1&2 Bottom Ash Pond
Units 3&4 Bottom Ash Pond,
Units 3&4 Auxiliary Scrubber Drain Pond, North Plant Area Drain Pond, Wash Tray Pond, Scrubber Drain Collection Pond (DC Pond),
Units 1-4 Sediment Retention Pond, and North Plant Sediment Retention Pond

Input Parameters as listed in the revised Section 2.3
Input parameters are listed in Table 2-5A, 2-5B, and 2-5C.

Comment 4 Section 2.3. Line 6. Given that the seepage rate calculations are head dependent, water levels from ponds where seepage was estimated should be actual water level elevation measurements and not assumed values.

Response: Actual elevations were used for the Units 1&2 Flyash Pond A and B and the Cooling Tower Blowdown Pond (Pond C) north and south, as water level elevations are recorded at these ponds on a weekly basis. Head in the remainder of the ponds was conservatively estimated by dividing pond capacity by pond area. The Units 3&4 Wash Tray Pond and Scrubber Drain

Collection Pond are notable exceptions. These ponds are no longer in use for process water. The minimal amount of water contained in these ponds is attributable to precipitation. Head in these ponds was conservatively assumed to be one foot.

Comment 5 Section 2.3. Line 13. By using the average value, it appears that PPLM assumed a less conservative (lower permeability) value, which may not be the case. A sensitivity analysis should be completed where a range in permeability values is evaluated.

Response: The permeability value used in the seepage calculation (0.525 feet per year) is more than an order of magnitude greater than the highest reported laboratory permeability. Note that lab permeability from 0.01 to 0.05 feet per year was referenced.

Comment 6. Section 2.3. Paragraph 2, Line 4. It is not clear how the pressure head value in the soil under all conditions can be assumed to be zero. If the soils were unsaturated, the head would be negative (suction). But if seepage or high water table had already saturated the soil, it would have some positive value. This generalized approach does not appear to be supported in the assumptions provided in Bouwer (1982) and used to calculate the seepage rate through the clay liner. Please provide additional information to support use of this assumption.

Response: Highly negative soil-water pressure head would not exist beneath seeping operational clay-lined ponds, except possibly during a temporally narrow period of initial wetting. At steady state, soil-water pressure becomes less negative and seepage becomes dependent on head above the liner, liner thickness, and liner permeability.

Under saturated conditions, some positive pressure head would exist; however, positive pressure head in seepage equation 1 of Bouwer (1982) would result in a reduction of calculated seepage. The conceptual model is that of vertical unsaturated flow between the bottom of clay liner and the water table. Positive pressure head was omitted to keep estimates conservative.

Comment 7. Section 2.3. Paragraph 2, Line 8. Please provide all data, calculations, and results used in the seepage rate estimates for clay lined ponds.

Response: Data and calculations are presented in Table 2-5A.

Comment 8. Section 2.3. Paragraph 3, Line 2. While modern geotextile liners without flaws greatly limit seepage, they do not necessarily "virtually eliminate" seepage. This statement should be revised or provide additional data to support this claim.

Response: This use of "virtually eliminates" versus "greatly limit" seepage appears to be a question of semantics and does not necessary affect the intent of the statement. We agree that a geotextile liner without flaws greatly limits seepage.

Comment:

> **DEQ requests that PPLM describe in detail the assumptions used to calculate the seepage estimates. DEQ requests that PPLM fully explain what "conservative estimates of pond construction parameters" means with respect to the calculation of pond seepage rates. Please explicitly explain that use of conservative parameters will give larger seepage estimates, more "conservative" estimates from an engineering viewpoint.**

Response: The section on Plant Site pond seepage calculations has been revised. All assumptions used in the calculations are described in detail. The use of conservative parameter assignments and the intent to make conservative over-estimates of seepage estimates is included in the discussion.

Comment:

> **DEQ requests that PPLM distinguish between "permeability" and "hydraulic conductivity" in the descriptions of both the clay-lined and geomembrane-lined ponds. In the first paragraph, PPLM discusses seepage from clay liners of a given permeability. In the second paragraph, PPLM discusses calculation of seepage through clay liners using the equation by Bouwer that uses saturated hydraulic conductivity of the liner, not the liner permeability. In the fourth paragraph on page 2-33, PPLM discusses synthetic liner permeability, while the paper by Giroud discusses liner permeability, soil permeability below the liner, hydraulic conductivities of liners, and hydraulic conductivities of soil below the liners. DEQ requests careful definitions of the different permeabilities and hydraulic conductivities of the liner materials, as well as the materials below the liners.**

Response: Seepage rates from ponds lined with earthen materials (i.e. clay) are parameterized by the hydraulic conductivity of the earthen liner. Hydraulic conductivity is also a relevant parameter where a clay liner is used beneath a geomembrane liner in what is known as a composite liner. Hydraulic conductivity is sometimes referred to as the coefficient of permeability; however, in the revised discussion of Plant Site pond seepage calculations only the term hydraulic conductivity is used to describe flow through saturated porous media. Flow through intact synthetic liner materials may occur as liquid permeation or water vapor transmission. Flow due to vapor transmission or liquid permeation is distinguished between flow through porous media in the revised section 2.3.

Comment:

> **DEQ requests that the table prepared by PPLM in response to Comment #7 by the contractor (Comment #7 Response Table Colstrip Steam Electric Plant Site Process Ponds Seepage Estimation) be included in the site report with modifications. The**

calculations for the clay-lined and geomembrane ponds have different input parameters; please divide the table into two parts. Please add total capacity in units of cubic feet and surface area in units of square feet. Please add liner permeability in units of feet per year. Further requests by DEQ concerning this table are addressed below. Please explain that the original seepage estimates for the ponds from Bechtel (1976) are from the original construction documents; please cite the full references in Section 7.0.

Response: Tables 2-5A, 2-5B, and 2-5C have been included to list input parameters and results of seepage estimates for clay-lined ponds, double-liner geomembrane systems, and single composite geomembrane liners, respectively. References used to develop seepage estimates are included in Section 7.0.

Comment:

DEQ requests that PPLM list the ponds where water levels are measured and how often the water levels in the ponds are measured. DEQ requests that PPLM list the ponds where water levels are not measured; for each of these ponds, DEQ requests that PPLM justify the assumed water level (head of liquid above liner) used in the seepage calculations.

Response: Actual elevations were used for the Units 1&2 Flyash Pond A and B and the Cooling Tower Blowdown Pond (Pond C) north and south, as water level elevations are recorded at these ponds on a weekly basis. Head in the remainder of the ponds was conservatively estimated by dividing pond capacity by pond area. The Units 3&4 Wash Tray Pond and Scrubber Drain Collection Pond are notable exceptions. These ponds are no longer in use for process water. The minimal amount of water contained in these ponds is attributable to precipitation. Head in these ponds was conservatively assumed to be one foot.

Comment:

The continued use of the seepage estimates requires that the following assumptions be valid:

1. **The clay and geosynthetic liners are composed of the correct material (The material composing the liners passed quality control and assurance procedures).**
2. **The clay and geosynthetic liners were installed correctly, passing all quality control and assurance procedures.**
3. **All liner properties have not changed over time. The liners have not degraded because of either environmental conditions or accidents.**

DEQ requests that PPLM describe in detail for each pond the justifications that these assumptions are valid.

Response: Pond liner properties specified in construction drawings or other documents were used to parameterize seepage estimates. Where these properties were not available, generally for ponds with minimal capacity, properties were assumed to be consistent with those *with known properties. PPLM adheres to quality assurance guidelines and has a record of maintaining or repairing ponds if/when the integrity of liner materials, geomembrane or clay, is compromised.*

Comment:

For both the clay-lined and geomembrane-lined pond, DEQ requests that PPL summarize the conditions and properties of the geologic materials below liners if known from geoengineering studies. Please list the nature of the material, the thickness of the material, and the measured conductivity of the material. If the material properties are not known, please specify the assumed properties.

Response: Data for material beneath the ponds is limited to laboratory analysis of hydraulic conductivity of silt/clay material used as a liner in the Units 1&2 Flyash Pond (A and B), wash tray pond, and cooling tower blowdown ponds (north and south). Hydraulic conductivity was reported to be 0.01 to 0.05 ft/yr. A clay blanket thickness of three feet is specified in construction drawings (Bechtel, 1974). These properties were assumed to be consistent for all ponds on the Plant Site; however, a hydraulic conductivity of 0.525 ft/yr was assigned to provide conservative seepage estimates.

Comment:

a. **Seepage Estimates for Clay Lined Ponds**

The form of seepage equation from Bouwer (1982) cited on page 2-33 assumes a geometry of a standing column of water of constant height over a constant-thickness clay liner without pond sides (Equation 1, Figure 3). This is not the situation for the Plant Site area ponds. The ponds are trapezoidal in vertical cross-section. Equation 2 in the Bouwer paper is for a trapezoidal cross-section pond with a column of water of constant height (Figure 1). Also, the ponds contain sediment (flyash) accumulated on the bottom with water above the flyash. The equation and figure for a pond with sediment above the clay liner are Equation 4 and Figure 6. Use of Equation 4 does require that the average vertical hydraulic conductivity of the saturated flyash in the pond either be measured or estimated. DEQ requests that PPLM explain why Equation 1 was used to calculate seepage rates instead of an equation that represented more realistic pond conditions.

Response: The form of the seepage equation (Bouwer, 1982) used in the original seepage estimates is the appropriate form. Where pond width is much greater than pond depth, trapezoidal geometry can be ignored and seepage through the pond bottom is essentially equal to seepage through the entire pond including sloped sides (Bouwer, 1982). The widths of all Plant Site ponds are greater than their associated depths. Also, seepage calculations were conservatively parameterized by assuming the entire area of each pond, not just the pond bottoms.

The former Units 3&4 Wash Tray Pond and Scrubber Drain Collection Pond are the only ponds that contain fly ash; and the Units 3&4 Bottom Ash Ponds are the only ponds that contain bottom ash. Both fly ash and bottom ash have higher hydraulic conductivity values than native silt/clay materials used to construct pond liners. The hydraulic conductivity of the liners, not the ash, limits seepage through the ponds. Thus, the form of the equation presented by Bouwer (1982) that considers accumulation of low permeability sediment on the pond liner was not used in the seepage estimates.

Comment:

> **DEQ requests that PPLM present the input parameters for the calculation of seepage from each pond. Please present these parameters in a table (i.e. the portion of the submitted table (Response to Comment #7 by contractor) concerning clay liners) and indicate which of these parameters are not known from measurements and are estimated, which of these parameters are known from liner specifications, and which are known from routine monitoring data. DEQ requests that PPLM add a column for the water depth above the liner.**

Response: Parameters used in the seepage calculation for each pond and the results of the seepage calculation for each pond are included in Table 2-5A (clay-lined ponds) and Tables 2-5B and 2-5C (geomembrane-lined ponds). Discussion of the origin of specific parameters (estimated, measured, or published values) is included in the revised Section 2-3

> **DEQ requests that PPLM individually list the leakage estimate for each pond.**

Response: Parameters used in the seepage calculation for each pond and the results of the seepage calculation for each pond are included in Table 2-5A (clay-lined ponds) and Tables 2-5B and 2-5C (geomembrane-lined ponds).

Comment:

> **Please incorporate the response to Comment #5 by the contractor into the discussion in the first paragraph in Section 2.3. DEQ requests that PPLM explain the term "assumed permeability" and why an average between assumed and lab permeability was used in the calculations. DEQ requests that PPLM explain that the**

permeability value used in the calculations results in a conservative (large estimate) of the seepage rate.

Comment 5 Section 2.3. Line 13. By using the average value, it appears that PPLM assumed a less conservative (lower permeability) value, which may not be the case. A sensitivity analysis should be completed where a range in permeability values is evaluated.

Response: The permeability value used in the seepage calculation (0.525 feet per year) is more than an order of magnitude greater than the highest reported laboratory permeability. Note that lab permeability from 0.01 to 0.05 feet per year was referenced (inserted from May 2013 comment response). The higher permeability assigned to seepage estimates was done so to arrive at a conservative seepage estimate.

Comment:

Please incorporate the response to Comment #6 by the contractor into the discussion in the first paragraph on page 2-33 following the presentation of the Bouwer Equation. Please specifically describe what conditions (negative, zero, or positive soil-water pressure head) were assumed for the listed leakage estimates. DEQ has not received any data from PPLM concerning soil-water properties nor groundwater levels from underneath any of the ponds. DEQ requests that PPLM explicitly acknowledge that there are no direct measurements of soil moisture or groundwater levels under the ponds and that PPLM has had to assume certain soil-water moistures and groundwater levels in order to perform the calculations. Please describe what the effect of "dry" (very unsaturated soil conditions) would be on the seepage estimates. Please describe what the effect of positive head pressure in the soil below the liner (saturated conditions) would be on the seepage estimates.

Comment 6. Section 2.3. Paragraph 2, Line 4. It is not clear how the pressure head value in the soil under all conditions can be assumed to be zero. If the soils were unsaturated, the head would be negative (suction). But if seepage or high water table had already saturated the soil, it would have some positive value. This generalized approach does not appear to be supported in the assumptions provided in Bouwer (1982) and used to calculate the seepage rate through the clay liner. Please provide additional information to support use of this assumption.

Response: Highly negative soil-water pressure head would not exist beneath seeping operational clay-lined ponds, except possibly during a temporally narrow period of initial wetting. At steady state, soil-water pressure becomes less negative and seepage becomes dependent on head above the liner, liner thickness, and liner permeability. The effects of negative pore pressure are assumed to be minimal but are admittedly poorly parameterized by our current knowledge of the system.

Under saturated conditions, some positive pressure head would exist; however, positive pressure head in seepage equation 1 of Bouwer (1982) would result in a reduction of calculated seepage. The conceptual model is that of vertical unsaturated flow between the *bottom of clay liner and the water table. Positive pressure head was omitted to keep estimates conservative. (inserted from May 2013 comment response*

Comment:

b. Seepage Estimates for Geomembrane Lined ponds

DEQ requests that PPL summarize the conditions and properties of the geologic materials below geomembrane liners if known from geoengineering studies. Please list the nature of the material, the thickness of the material, and the measured conductivity of the material. If the material properties are not known, please specify the assumed properties.

Response: Data for material beneath the ponds is limited to laboratory analysis of hydraulic conductivity of silt/clay material used as a liner in the Units 1&2 Flyash Pond (A and B), wash tray pond, and cooling tower blowdown ponds (north and south). Hydraulic conductivity was reported to be 0.01 to 0.05 ft/yr. A clay blanket thickness of three feet is specified in construction drawings (Bechtel, 1974). These properties were assumed to be consistent for all ponds on the Plant Site; however, a hydraulic conductivity of 0.525 ft/yr was assigned to provide conservative seepage estimates. Material properties for geomembrane liners were assigned based on known pond construction specifications and published values of liner water vapor transmission (permeance for specific liner materials.

Comment:

DEQ investigation shows that there are several "Giroud Equations" of different form used to calculate seepage through geomembrane liners. DEQ requests that PPLM explicitly write out the form of the Giroud equation used to calculate pond seepage. Please define all factors and variables. Please discuss the theoretical and empirical derivations of the equation. Please discuss the roles of the pressure head above the geomembrane and the saturated hydraulic conductivity of the soil below the geomembrane. DEQ requests that PPLM explicitly state that the exponents in the formula are empirically derived from fits of experimental data to various forms of the equation. DEQ requests that PPLM justify that the formula is appropriate to use to calculate seepage through the PPLM geomembrane liners.

Response: Specific formulae and justification for their use in seepage estimates for geomembrane-lined Plant Site Ponds are discussed in the revised Section 2.3. Variables are defined in Tables 2-5B and 2-5C.

Comment:

i. **The cited 1977 Giroud paper calculates leakage through a composite liner consisting of a geomembrane layer over a low-permeability soil. Types of low-permeability soils cited in Section 1.2 of the paper are compacted clay**

liner or geosynthetic clay liner (hydraulic conductivities on the order of ten to the negative ninth to ten to the negative twelfth meters per second). Please discuss the measured or assumed value of permeability in the soil below each of the PPLM liners.

Response: There was no reference made to a "1977 Giroud paper". Hydraulic conductivity of the compacted silt/clay media is discussed at length in the revised Section 2.3. The theories submitted by Giroud and Bonaparte (1989), Giroud et al. (1992 and 1994), and Giroud (1997) do not stipulate a maximum hydraulic conductivity of the soil under-liner. However, if the hydraulic conductivity of the soil component does not limit flow, seepage through a defect may be better constrained by Bernouli's equation for orifice flow. The silt/clay medium beneath geomembrane liners at PPLM is limiting to flow. Note that the hydraulic conductivity assigned to seepage estimates is 0.525 ft/year (5.1 x 10^{-9} m/second).

ii **In the 1977 Giroud paper, a distinction is made between the "small head case" liquid head on liner less than the thickness of low-permeability soil under the liner) and the "large head case" (liquid head on liner is greater than the thickness of low-permeability soil under the liner). Please state which condition is assumed in the calculations. Different equations are cited for the two cases.**

Response: There was no reference made to a "1977 Giroud paper". Equations used to estimate seepage from geomembrane-lined ponds are listed in Tables 2-5B and 2-5C of the revised Section 2.3.

iii. **Please define the contact quality factor. Please discuss the role of the contact quality factor, the range of possible values of this factor, and the value used for the calculations. Please justify the values used. Please cite available evidence from quality control and quality assurance inspections performed during liner installation.**

Response: The contact quality factor is a measure of how well the geomembrane liner is in contact with the underlying medium. Two possible values are presented by Giroud (1997) for this factor: 1. Assuming poor contact; and 2. Assuming good contact. The more conservative factor (poor contact) results in seepage estimates approximately five times greater than those made using the lower bounding factor. A poor contact quality factor was assumed in the evaluation to provide a conservative seepage estimate.

iv. **Please define the shape of the defect area, defect shape, and defect density assumed for the calculations. On page 2-34, PPLM states that a defect area of**

0.15 square inches and a defect density of one defect per acre were assumed. Please compare these numbers with numbers from the liner factory specifications and quality control and quality assurance inspections during and after liner installation. Please cite evidence concerning typical acceptable industry manufacturing and post-installation standards for the liner materials used in the ponds.

Response: Defect shape, area, and density assigned to the seepage estimates for geomembrane liners are listed in the revised Section 2.3. Based on review of liner defect densities (Giroud et al., 1994),one to two defects per 4,000 m^2 (~1 acre) are a conservative representation for landfill liners. For the open ponds, a defect density of 10 per 4,000 m^2 was assumed to provide a conservative seepage estimate.

Comment:

DEQ requests that PPLM outline and explain how the Giroud equation was used to calculate seepage for the ponds with synthetic liners. DEQ requests that PPLM present the values of the input parameters for the calculation of seepage from each pond. Please present these parameters in a table (i.e. the portion of the submitted table (Response to Comment #7 by contractor) concerning geomembrane liners) and indicate which of these parameters are estimated or assumed, which of these parameters are known from liner specifications, which of these parameters are known from pre-installation geotechnical studies, which parameters are known from post-installation quality control and quality assurance studies of the liners, and which are known from routine monitoring data. Please include columns for the contact quality factor, the area of the circular defect, the density of the defects, the pressure head of water above the liner, and the saturated hydraulic conductivity of the soil below the liner. For the ponds that are double lined with a leachate collection system, please precisely describe whether the seepage rate is through the top liner only or is the rate through both liners.

Comment 7. Section 2.3. Paragraph 2, Line 8. Please provide all data, calculations, and results used in the seepage rate estimates for clay lined ponds.

Response: Data and calculations are presented in Tables 2-5B and 2-5C in the revised Section 2.3.

Comment:

DEQ requests that PPLM resolve a question concerning the submitted table concerning the values in the column "Permeability of liner (ft. /day)". DEQ requests

that PPLM discuss whether or not the values in this column are the intrinsic permeabilities of the geomembrane material without defects. The cited values are much larger than usual intrinsic material values. If these are not the intrinsic permeabilities, please discuss what these numbers represent.

DEQ requests that PPLM individually list the leakage estimate for each pond.

Response: Seepage due to permeation and seepage through defects is calculated in Table 2-5B and 2-5C of the revised Section 2.3.

In the second line of the second paragraph of page 2-33, DEQ requests that PPLM change "virtually eliminate seepage" to "greatly limit seepage".

Response: This sentence has been stricken from the revised Section 2.3.

DEQ requests further explanation of the fourth sentence on page 2-34: "These estimates of seepage from lined ponds are consistent with monitoring that is conducted on leachate collection systems beneath the ponds." DEQ requests that PPL explicitly acknowledge that relevant monitoring data on the lined pond seepage rates is limited to at most 4 ponds (lined ponds with leachate collection) out of 9 lined ponds. The relevant monitoring data currently available to DEQ are the pumping rates for the primary (between liners) and secondary (below liner) leachate collection systems associated with the Units 1 & 2 Flyash Pond B Pond and the Units 1 & 2 Bottom Ash Clearwell Pond presented in the Annual Report. In the 2013 Annual Report (Table 6-1) the reported average pumping rates for the collection systems in the two ponds are:

Units 1 & 2 Flyash Pond B Pond	**38.5 gpm (primary)**
	6.2 gpm (secondary)
Units 1 & 2 Bottom Ash Clearwell	**1.1 gpm (primary)**
	0.1 gpm (secondary)

Groundwater is believed to be elevated under the B Pond; the large volume being pumped is thought to be a mixture of native groundwater and leakage from the pond. Therefore the pumping rates for the collection systems associated with the Units 1 &2 Bottom Ash Clearwell are the only relevant data that DEQ currently has. DEQ requests that PPL compare the calculated seepage rate for the Units 1 & 2 Bottom Ash

Clearwell (0.033 gpm) with the measured pumping rates and comment on the differences. If other data are available concerning the seepage rates for the other five lined ponds without leachate collection, DEQ requests that PPL provide that information and incorporate the information into the Plant Site Report.

Response: The utility of comparison between the seepage estimates and observed leachate collection rates at the Units 1&2 Flyash Pond B and Units 1&2 Bottom Ash Clearwell is discussed in the revised Section 2.3. Estimates of seepage through the primary liner of the double-lined Units 1&2 Bottom Ash Clearwell are consistent with the amount of water pumped from the between-liner sump. Water collected from beneath the Units 1&2 Bottom Ash Clearwell secondary liner is greater than that predicted in the seepage analysis. The Additional water collected beneath the liner system could be attributable to native groundwater or water from other nearby ponds.

The under-liner leachate collection system at the Units 1&2 Flyash Pond B primarily collects groundwater but may also collect seepage from adjacent clay-lined Pond A. Note that 27 gpm of seepage is estimated from the neighboring pond. Water that is collected by the between-liner leachate collection system (6.2 gpm in 2013) is likely attributable to the under liner collection system. The two collection systems share a common pipeline that is routed and discharges to Pond B. A fraction of the water that is pumped from the under liner collection system likely flows unchecked from the under-liner system to the secondary collection sump. Thus, as DEQ suggests, the leachate collection rates at the Units 1&2 Pond B are an unreliable measure of the amount of seepage from the pond. No information related to seepage rates from other plant site ponds is available; as such, none is included in the Plant Site Report.

DEQ requests further information concerning the fifth sentence on page 2-34: "For example, the leachate collection system beneath the Units 1 & 2 B Pond is typically dry (Pers. Comm., Mike Holzworth, 2012)." DEQ requests that PPLM explicitly reconcile the quoted sentence with the leachate collection pumping rates for Units 1 & 2 Flyash Pond B Pond previously presented.

Response: This statement is reconciled in the revised section 2.3.

DEQ requests that PPLM supply DEQ with a copy of the 1994 citation by Giroud, Badu-Tweneboah, and Soderman listed in Section 7.0, References.

Response: The requested document will be provided.

Comment:

C. Section 3.0 Summary of Investigations

1. **Section 3.1 Past Releases**

 DEQ requests that the past release information be transferred to a table titled "Table 3-1 Summary of process water releases and actions taken, Colstrip Steam Electric Station, Administrative Order on Consent, Plant Site Area." DEQ requests that the table have six columns: date of release; cause of release; estimated amount loss in gallons; actions taken to contain and mitigate the spill; fate of the spilled material especially into shallow groundwater or the East Fork of Armells Creek; details concerning the written report including title, date of issue, and a summary of the report.

 PPLM has supplied a table of past releases ("Comment #9 Response Table") as part of the response of PPLM to the comments by the contractor. DEQ requests that PPLM use the Comment #9 Response Table as the basis to construct the requested table. In the Comment #9 Response Table, DEQ requests PPLM complete the information concerning the cause for the June 25, 1991, the 1991 Units 3 & 4 Bottom Ash Ponds, June 16, 2002, July 23, 2002, and November 15, 2002 releases. DEQ is aware of more recent releases in the Plant Site Area than the most recent release listed (November 15, 2005). DEQ requests that PPLM update the table.

 This request is the DEQ response to Comment #9 by the contractor.

Comment 9. Section 3.1 Paragraph 1. Line 3 and Bullet 3. All process water related spills should be quantified and presented clearly in a table in the Plant Site Report.

*Response: A table numbered 3-1 has been prepared and incorporated into the report including the information requested by MDEQ. Note that the MDEQ request to include "***details concerning the written report including title, date of issue, and a summary of the report"** *were addressed by adding a report reference # to the last column on Table 3-1 that cross-references the report reference # on the left side of Table 3-2 (formerly Table 3-1) to identify the title of the report, date, and summary.*

Comment:

2. **Section 3.2 Past Investigations**

 Currently the summary of past investigations is listed as Table 3-1. DEQ will not request changes to tables entries in Table 3-1 submitted in the original draft submitted in February 2013.

DEQ requests that the investigations written and submitted to DEQ since November 2012 be added to Table 3-1.

Response: The original Table 3-1 (now Table 3-2) has been updated with investigational reports conducted from November 2012 through 2014.

Comment:

3. **Section 3.3 Synopsis of Past Spills, Investigations, Mitigation Status**

   It is unclear to DEQ what the difference is between the information discussed in Section 3.1 (Past Releases) and the information discussed in this section. If the information is the same, then the table proposed by DEQ for Section 3.1 will suffice for this section; please reference the table in this section. If the information is different, then DEQ requests that the information covering the past spills, investigations, and mitigation status be separated out from Table 3-1 and added as a separate table to this report.

Response: Text from Section 3-3 has been integrated into Section 3-1. Section 3-3 has been eliminated from the report.

Comment:

4. **Section 3.4 Current Site Conditions**
5. **DEQ requests that PPLM include a new subsection in Section 3.4 concerning the surface water measurements in East Fork Armells Creek at the stations within the Plant Site Area boundaries. Please discuss the parameters measured along the stream. Please discuss the seasonal character of the stream and how this affects the timing of the measurements. Please summarize the findings of the entire set of synoptic runs; DEQ recognizes that year-to-year, stream properties will change. Please summarize which stream reaches tend to be gaining or losing, or are changeable. Please summarize which stream reaches tend to show large increases or decreases in dissolved parameter concentrations (chloride, boron, nitrate plus nitrite, sulfate) as well as calcium to magnesium ratio and TDS compared to neighboring reaches. Please summarize the general pattern of stream loading for the dissolved parameters previously mentioned as well as calcium and magnesium. Please note the particular reaches that typically show larger than average or smaller than average loading. Please define the location of a stream reach by reference to the direction and approximate distance to the western Plant Site ponds.**

DEQ requests that Table 3-1, 2013 Annual Report, "Groundwater Quality Parameter List" be added to the site report as a new table and referenced in Section 3.4.

Although not a PPLM well, the "WECO Dewatering Well" (located north of the Unit 3 & 4 Bottom Ash Pond Area and east of Units 3 & 4) has been incorporated into the analysis of groundwater flow and remediation effectiveness in the Plant Site Report. The role of this well in groundwater capture is mentioned in Section 3.6.2. Data concerning the pumping rate of this well are incorporated into the Annual Reports. The role of the well in capture is modeled in the groundwater model report. DEQ concurs that this well plays an important role in the Plant Site capture analysis. DEQ requests that further information concerning the well be incorporated into the report. DEQ requests that the well log be added to the report in an appendix and discussed in Section 3.4.1; DEQ requests information concerning the depth interval of the geological unit contributing water to the well be added to the report. DEQ requests that the water quality data supplied by PPLM as part of the response (Comment 17) to the contractor in the form of a table (Comment 17 Response Table, WECO Well Water Quality) be added to the report and discussed in Section 3.6.2, Remedy Effectiveness Monitoring Units 3 & 4 Bottom Ash Ponds Subarea. If the water quality data from this well were not used in preparing the maps showing chemical concentration (Figures 3-2, 3-3, 3-4, 3-5, 3-6, and 3-7), please use the chemical data in revising the maps.

Response: A section summarizing synoptic runs on East Fork Armells Creek has been added to the report.

Well construction information has been added to the report and a well log will be provided to MDEQ. The WECO well was installed to a depth of 65 feet to the base of the spoil as a dewatering well at a Western Energy Coal crusher.

Water quality from the WECO well was not used in the original contouring as it would not affect any of the contouring on the Plant Site. However, data from the WECO well has been added to these figures as requested.

Jun 06 03 01:09p cblakman (406) 748-5202 p.2

Welo dewatering well by E Crusher house

WELL AND PUMP DATA

Location of Well: ROSEBUD MINE, COLSTRIP MT

County	Township Number	Range Number	Section No.	Fraction
ROSEBUD	2 N	41 E	35	SESWNW

Street Address and City or Distance and Direction from Road Intersections

Property owner's name and address: WESTERN ENERGY CO. P.O. BOX 99 COLSTRIP, MT 59323

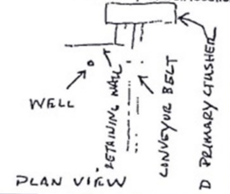
Show exact location of well in section grid with an 'x' — N, S, 1 mile

Addition Name

Block Number

Lot Number

Sketch map of well location



Remarks, Elevation, Source of Data, etc.

Well depth: 65

Datum point from which all measurements are taken: surface

Method of Drilling: ☐ Cable tool ☐ Direct rotary ☐ Reverse rotary ☐ Hollow rod ☒ Air rotary ☐ Jetted ☐ Driven ☐ Bucket auger ☐ Flight auger ☐ Dug ☐ ____

Use: ☐ Domestic ☐ Irrigation ☒ Test Well ☐ Public supply ☐ Municipal ☐ Heating or cooling ☐ Industrial ☐ Commercial ☐ Monitoring ☐ ____

Casing Type: ☐ Steel ☐ Galv. ☒ PVC ☐ SS ☐ Threaded ☐ Welded ☐ Solvent welded

Height above/below surface: ± 2'

Drive shoe? Yes ___ No X

6 in to 25 ft Wgt ___ lb/ft Sch. No. 40 — Hole diameter 8 in to

Borehole data

Formation Log	Color	Hardness	From	To
CLAY LOAM	BROWN		0'	5'
SILTY CLAY	LTR. BRN.		5'	10'
SILTY CLAY LOAM	BRN.		10'	15'
SANDY CLAY LOAM	LTR BRN		15'	20
SANDY CLAY LOAM W/ ... & PYRITE < 5%	MIX		20'	30
SILTY CLAY 50% & 50% SANDSTONE COAL & PYRITE	MIX		30'	35'
35% CLAY W/ COAL & SANDSTONE	MIX		35'	40'
30 CLAY W/ 70% COAL & PYRITE	MIX		40'	50'
COAL	BLACK		50'	55'
COAL W/ TRACE CLAY	BLACK		55'	60
SHALE SANDSTONE & PYRITE	MIX		60	65

Intake Portion of Well

Screen type: 20 SLOT PVC or open hole from ___ ft to ___

Manufacturer: MONO FLEX

Material: PVC Dia. ___

Fittings: GLUE ON BOTTOM REST THREADED Length ___

Set between 25 ft and 65 ft Slot 20

Method of installation ___

Filter Pack

Source: COLORADO SILICA SAND Gradation 10-16

Method of installation: TRICKLE Composition ___

Volume used ___ Depth to top of f.p ___

Grout

Used? ☒ Yes ☐ No Volume used ___

☐ Neat Cement ☒ Bentonite ☐ ___

Method of installation: TRICKLE

Depth: from 17 ft to 23

Development

Method: AIR Duration 4 hrs

Dates: 12/8/94 Sand content after 4 hrs ___

Chemicals used: NONE

Static Water Level: 19.8' ft ☒ below ☐ above grade

Date measured: 12/8/94

Pumping Water Level: 32' ft ☒ below ☐ above grade Date 12/21/94

After 2 hrs hrs pumping at 115 g

Specific Capacity

___ gpm/ft of drawdown at ___ hour Date ___

Pump

Date installed: 12/29 Type: SUBMERSIBLE

Manufacturer: GRUNDFOS Model No. SP27-135874-4

H.P. 7.5 Volts ___ Capacity 135 GPM

Depth of pump intake setting 58' No. of stages 1

☐ Oil ☒ Water lubrication Power source ___

Material of drop pipe: 3" GALVANIZED bowls ___

shafting ___, impellers ___ Bowl dia ___

Column pipe dia ___ Length ___ Modifications ___

Well Head Completion: WELL SEAL

☐ Pitless adaptor ☐ Basement offset Distance above grade ___

Nearest Sources of Possible Contamination

___ ft Direction ___ Type ___

Well disinfected upon completion? ☐ Yes ☐ No

Geophysical Logs Run

Contractor Name and Address

Water Quality

Sample taken? ☒ Yes ☐ No

Where analyzed: ENERGY LABS, BILLINGS

Name of Driller: ADT / PRO-PUMP & EQUIPMENT LAUREL, MT

State License Number: MW -> 271. NWWL -> 532

Date well completed: 12/7/94

Comment:

i. Section 3.4.1 Site Hydrogeology

DEQ requests that PPLM incorporate enough details of the regional geology to communicate the geological complexities that govern the area groundwater flow. Please include details concerning the depositional history of the coal beds and the Fort Union Formation. Please add enough detail concerning the climate and surface processes (e.g. streams transporting sediment among coal swamps) during deposition to explain the sedimentary structures and coal beds formed. Please include and define the following terms in the discussion: meandering stream; braided stream; anastomosing stream. DEQ requests that PPLM explain why laterally the sedimentary formations change physical characteristics (e.g. average grain size, porosity, and permeability) enough to affect groundwater flow. DEQ requests that PPLM explain why the nature of the coal beds (thickness and chemical composition) changes laterally, including coal bed splitting and pinching out. Please cite geological references and add them to the reference list in Section 7.0.

DEQ requests that PPLM also explain how more recent natural processes (e.g. clinker formation, surface erosion) have altered the area geology and affected groundwater flow. DEQ requests that PPLM describe how the surface erosion caused by East Fork Armells Creek has affected the lateral extent of the shallow units above the Sub McKay. Please indicate on a map where the surface erosion by the stream has occurred. Please indicate on a map where clinker occurs in the Plant Site Area.

Response: A new section "Regional and Local Geology" - 3.3.1 has been added to the report.

Clinker is not present on the plant site proper. Logs for 6M and 16M both indicate a two foot clinker interval above the McKay Coal. However, the McKay is intact and unburned. As such, it is unlikely that this interval is actually clinker formed as the result of coal. Rather, the interval is likely a highly oxidized interval of sandstone. There is clinker present in the far northwest area defined as Plant Site but it does not play a role in the hydrogeology of the facility. This small area of clinker is directly north of the easternmost Colstrip Sewage Effluent Pond, is located at the top of a hill, and is above the water table.

Comment:

On page 3-26, please make the following changes concerning the geological units:

1. **With respect to the description of the Rosebud Coal and the McKay Coal, please define the word '"cleated" as systematic fractures that have a common spatial orientation. Please explain that orientation of the cleats often**

determines coal permeability, hydraulic conductivity, and direction of groundwater flow in the coal

2. **In the description of Rosebud Coal, please add that the Rosebud Coal bed lies stratigraphically over the McKay Coal bed.**
3. **With respect to clinker, please how fractures in the clinker determine the permeability, hydraulic conductivity, and direction of groundwater flow in the clinker.**

DEQ requests that PPLM incorporate enough detail to discuss how historical activities (i.e. surface coal mining) have impacted the local geology. Please discuss the removal of shallow material above and including the Rosebud Coal during mining. Please indicate on a map where the shallow units were removed. Please describe how the removed overburden is emplaced into the mine sites and describe the geological complexities of the emplaced mine spoil material. DEQ requests that PPLM document the extent and estimated depth of mine spoil in the eastern and northern portion of the Plant Site. DEQ requests that PPLM discuss the heterogeneity of the mine spoil. Please discuss the complexities of determining groundwater flow direction and static water level in the mine spoils.

DEQ requests that PPLM discuss, based on known water levels and well yields, the important aquifers among the geological units discussed in Section 3.4.1. In this section of the report, DEQ defines "aquifer" to mean water-bearing. If the aquifer properties of a unit vary significantly in the Plant Site, please discuss the variation.

Response: A figure showing the distribution of spoil on the plant site has been added to the report. Text has been added to the site hydrogeology section as requested.

Comment:

ii. Section 3.4.2 Distribution of Indicator Parameters

DEQ requests that at the first occurrence in this section of the reference to or use of the background screening levels (BSLs) of the indicator parameters, PPLM note in the text or in a footnote on the same page that the BSLs are under review as of July 2014.

DEQ requests that PPLM use the same set of indicator parameters (specific conductance, boron, chloride, and sulfate) for all three site reports. Please replace all discussion of TDS with discussions of specific conductance.

If PPLM wishes to discuss bromide, please discuss bromide as a potential indicator parameter and discuss the limitations of utility of bromide including:

1) **The recent introduction of bromide into plant operations.**
2) **The relatively small horizontal extent of bromide at elevated concentrations in groundwater in the Plant Site Area.**
3) **Calculations of bromide background screening levels for only two intervals (alluvium and spoils) in the 2007 ARCADIS study.**
4) **The large variability of bromide concentration in pond chemical profiles. Please see the comments for Section 2.2.**

Response: Additional text has been added to the report regarding bromide.

Comment:

a. **Quantified background screening levels for indicator parameters**

DEQ requests that PPLM explain that the background screening levels are for the indicator parameters that are used to evaluate the impact of process pond on groundwater. Please include these values in a new table in the text. Please include the values for wells completed in alluvial, spoil, and bedrock units as specified in the 2007 ARCADIS study.

Please define and explain the origin of the baseline screening levels. DEQ requests that PPLM summarize the methodology and the results of the 2007 ARCADIS study that evaluated the background water quality. Please explain how the set of wells unaffected by process pond water and used in the study was selected. Please include Table 1 from the ARCADIS study that lists the wells used in the study and Figure 1 that shows the location of the wells. Please explain how the set of wells was subdivided into three categories based on hydrogeologic unit of completion (alluvium, spoils, bedrock).

Please summarize and explain the statistical methodology of the ARCADIS study. DEQ requests that PPLM briefly describe the data analysis:

1. **The graphical analysis of the data**
2. **Calculation of summary statistics for each parameter.**
3. **Identification and testing for outlier data to be eliminated.**
4. **Trend analysis to test for data trends, including seasonal cycles.**
5. **Removal of suspect data.**

6. **Calculation of baseline screening levels as the level at which there is great statistical confidence (95% confidence) that the baseline screening level is not higher in value.**

DEQ requests that PPLM include Table 5 from the ARCADIS study and indicate the column with the background screening levels.

In Table 5 of the ARCADIS study, three conductivity parameters are listed: two Field Parameters ("Field Conductivity" and "SpecCond"), located on page 2; "SpecCond" located on page 3. DEQ notes that for the three conductivity parameters listed in Table 5, the number of samples, summary statistics, and the "Nonparametric BSL" are all different. DEQ requests that PPLM state which conductivity parameters from this table are used in PPLM operations, what are the relevant background screening levels, and what are the justifications for their use.

DEQ requests that PPLM describe how the background screening levels are used to determine if a well is impacted by process pond water. Please include cases where not all of the water quality data for the indicator parameters are above the background screening levels.

Please cite and add to the references all the EPA guidance documents used in the determination of the background water quality. Please cite and add the reference to the software used in the calculations, ProUCL4.

PPLM may wish to place the requested documentation from the 2007 ARCADIS study in an appendix and then reference the appendix in the discussion.

Response: BSL's were calculated for more than just the indicator parameters. A table has been added to the report listing BSL's for various parameters as listed in Table 5 of the 2007 Arcadis report. BSL's for both field and laboratory SC were calculated as indicated in the comment. Laboratory SC values are typically used in the report. References to the Arcadis 2007 report have been added to the report with the appropriate pages identified to address the various questions above. The Arcadis report is a "Stand Alone" report, and as such, MDEQ should review the report rather than rely on excerpts and tables withdrawn from the report. To assist with this effort, a copy of the report has been included in the revised report as Appendix D.

MDEQ references Figure 1 of the Arcadis report as a way to illustrate locations of wells used in the statistical evaluation. Locations are actually shown on Figures 1, 2, and 3 of the Arcadis Report. These figures can be found in the Figures section of the 2007 Arcadis Report (Appendix D of the revised report). A reference to those figures is included in the report. Drawing files are not available for inclusion in the report.

Comment:

a. **Other indicator parameters without background screening levels**

DEQ requests that PPLM define and describe the use of any indicator parameters that are used without background screening levels (e.g. the ratio of calcium to magnesium concentrations in groundwater).

b. **Analysis of impact of process pond water on groundwater**

DEQ requests that PPLM use the same set of indicator parameters for all three site reports unless documentation is provided that special chemical characteristics of ponds in a particular area require a special set of parameters.

Using the specified indicator parameters, DEQ requests that PPLM further document the impact of process pond water at the Plant Site Area. Currently five maps are in the report: specific conductance in the shallow units (Fig 3-2); specific conductance in McKay coal (Fig 3-3); boron concentration in shallow units (Fig 3-4); boron concentration in McKay Coal (Fig 3-5); chloride concentration in shallow units (Fig 3-6). The rationale why these particular maps have been presented is not clear. DEQ requests that further maps be prepared showing the distribution of values of indicator parameters for all the cited indicator parameters including sulfate concentration. These additional maps include chloride in McKay Coal, sulfate concentration in shallow units, and sulfate concentration in McKay Coal.

DEQ requests that PPLM explain what are meant by "shallow stratigraphic units." DEQ presumes that these units include at least the alluvium/colluvium, fill, remnant Rosebud Coal, Rosebud Overburden, and spoil. DEQ requests that PPLM explain why indicator parameters are mapped on combined shallow units maps (Figures 3-2, 3-4, and 3-6), instead of on individual shallow unit maps. DEQ requests that either all of the indicator parameters be mapped on separate maps for each of the shallow units or that clear boundaries between shallow units be placed on the maps.

DEQ requests that PPLM further define the current status of dissolved bromide as either a fully tested or a candidate parameter. If PPLM decides that bromide is a fully tested parameter, DEQ requests that maps be added

to the report showing the extent of dissolved bromide in the groundwater. DEQ requests that PPLM add the date (year) to the description of the introduction of bromide to remove mercury from flue gas (page 3-27, second paragraph, first sentence).

DEQ requests that PPLM explain why maps showing the extent of the indicator parameters for the other deeper geological units besides McKay Coal including clinker, interburden, and Sub-McKay were not included in the report. If one of the reasons is low detected concentrations of the indicator parameters in groundwater samples, DEQ requests documentation of these concentrations.

DEQ requests that PPLM explicitly describe how areas of process water impact (defined by the isoconcentration contours) are defined on maps such as Figures 3-2, 3-3, and 3-4. This includes the selection of water quality data from capture and monitoring wells as well as computer software used and judgments based on familiarity with the groundwater data.

Response: Use of the ratio of calcium to magnesium as an indicator parameter has been explained as requested.

As per the second point, PPLM uses the same set of indicator parameters in its analysis at the Colstrip SES. Presentation of the indicators is typically conducted in a manner that will minimize the volume of text necessary to convey an interpretation or observation, but will show the major points that are to be described for, if water quality analysis shows an abrupt increase in SC and sulfate, but only minimal change in chloride or boron, graphs for only the SC and sulfate might be shown. This results in not all parameters being presented in each case. Figures have been added for the sub-McKay interval and additional iso-concentration maps. The iso-concentration maps now in the report include SC (lab), sulfate, boron and chloride.

As per second full paragraph of "b." the following text has been added to the report. "For the purposes of this discussion, shallow units are defined as units that may contain water under water table conditions and are typically the first water encountered. The shallow interval is comprised of alluvium, colluvium, shallow bedrock(overburden) overlying the Rosebud Coal, and spoil. These units are typically stratigraphically connected and groundwater flow can occur laterally between the units. The exception is the Rosebud overburden (shallow bedrock) and remnants of the Rosebud Coal which exist in the south central portion of the Plant Site. This area is very small and has been considered as a whole since vertical flow from the overburden to the Rosebud is expected to occur. If it does not occur, there is only a short distance of lateral flow in the overburden before erosion, mining, or other development activities have removed the overburden. In this case, water from the overburden flows downward into the Rosebud interval. The Rosebud Coal is also limited in areal extent on the Plant Site. Groundwater present in the Rosebud Coal flows laterally either into spoil, colluvium, or alluvium. Hence, the units are handled as *one for this analysis." Additional maps have been added as requested. In addition, although not specifically requested in this comment, the maps have been updated using validated spring 2014 data.*

Regarding Bromide as an indicator parameter (third full paragraph under "b"): Text has been added to the report explaining the timing of bromide addition to the scrubbing process and potential difficulties using bromide as an indicator of process water at the facility. At this time, bromide is not considered a reliable indicator parameter.

Regarding fourth full paragraph under "b": Limited data are available to map the sub-Mckay. However, maps will be added to the revised report using available data for the mapping. Additional data have become available since the issuance of the Site History Report for the Plant Site in December 2013. Few wells are completed in the interburden. The Rosebud Coal has been removed by erosion in most areas that do have wells in the interburden. In these areas, the interburden either represents the shallowest water bearing unit or is in direct connection with unconsolidated deposits. The clinker would be mapped with the shallow interval and is not a "deeper" hydrostratigraphic unit. The clinker would be stratigraphcially equivalent to Rosebud Coal and/or spoil. Clinker is absent from the Plant Site proper, occurring only on ridgetops adjacent to Power Road. The clinker is dry at this location.

Regarding fifth full paragraph under "b": Text has been added to the report to describe how groundwater quality is evaluated using a multiple lines of evidence approach to identify areas with impacts or suspected impacted areas.

Comment:

iii. Section 3.4.3 Groundwater Flow

a. Potentiometric Maps

DEQ requests the methodology used to construct the potentiometric surfaces in Figures 3-8 and 3-9. Please discuss how the water level measurements used to construct the potentiometric surfaces are performed in the two types of wells, monitoring and capture wells. Please discuss how PPLM determines the potentiometric depressions representing cones of depressions around capture wells. DEQ requests that PPLM discuss the selection of wells to construct the surfaces. DEQ requests that PPLM justify using a large number of capture wells and a smaller number of capture wells in the following subareas of the Plant Site Area: immediately west of the Units 1 & 2 AB Ponds; southwest of the Units 1 & 2 AB Ponds; north of the Sediment Retention Pond and west of the North Plant Retention Ponds. Please discuss the role of head loss during pumping in the capture wells with respect to measurement of potentiometric elevation.

DEQ requests that PPLM justify why the potentiometric surface was mapped for the combined shallow units (Figure 3-8) instead of separately for each shallow unit. DEQ requests that either separate maps be added for the separate shallow units or lines showing the lateral extents of the shallow units be added to Figure 3-8.

DEQ requests that PPLM justify why only the potentiometric surface for one deeper unit, McKay Coal, was mapped in Figure 3-9.

DEQ requests that PPLM describe what are the seasonal and long-term changes in the potentiometric maps. DEQ request that PPLM describe how the documented long-term increases in water level in the southeastern boundary of the area (described in the groundwater model report) affect the potentiometric map.

DEQ requests that PPLM discuss the relationship of the potentiometric surfaces in Figures 3-8 and 3-9 with expected groundwater flow directions. DEQ requests that PPLM explain in writing that, in the geological setting of Colstrip (in the presence of anisotropic and inhomogeneous geologic material), groundwater flow direction and flux may actually be different than predicted from the potentiometric surfaces.

DEQ requests that PPLM more fully document the water level data in order to substantiate several statements in the third paragraph of Section 3.4.3. The potentiometric data shown along the eastern boundary of the Plant Site (Figure 3-8) are sparse east of the Units 3 & 4 Bottom Ash Ponds, the WECO Sediment Pond, and the Units 3 & 4 Wash Tray Pond. PPLM asserts that on the eastern edge of the Plant Site shallow groundwater appears to flow to the southeast. PPLM asserts that there is a shallow groundwater divide east of the Plant Site ponds. Please provide more evidence to support these statements.

DEQ requests that PPLM discuss the deeper regional groundwater flow in the Tongue River Member of the Fort Union Formation (sub McKay material). Please cite references and add the citations to the reference list in Section 7.0.

Response: "iii. a." above first paragraph: Construction methodology for water table and potentiometric maps has been added to the text of the report.

As per second paragraph in "iii. a": However, the following is discussion of head losses that can affect the water level measured inside a pumping wel has been added to the text. Multiple types of head losses occur in and around a pumping well. These are formation losses, disturbed *zone losses, and well losses. Formation head losses are a function of the rate at which water is removed from a well and the hydraulic conductivity. Head losses also occur at the interface between the formation and the portion of the formation that is disturbed during the drilling process. This "disturbed zone" may have lower permeability than the surrounding formation from an acumulation of drilling fluids, fines pushed into the formation during drilling, or other affects of the drilling process. A head loss will occur where the hydraulic conductivity at the interface between the two medium is lower than that of the adjacent water bearing formation. Well losses are a result of the well installation itself and are a function of restrictions of groundwater flow to a well. These may be caused by the presence of a filter pack, size and amount of perforations, type of flow into the well (turbulent versus laminar), and post-construction factors such as scaling of perforations causing blockage. Any or all of these factors may restrict flow to a well causing water levels inside a well to be lower than those in the adjacent formation. Water levels measured inside a pumping well are typically an overestimate of actual drawdown affects outside of the pumping well because of the head losses not associated with the formation.*

The following text was added to the report (new report section 3.3.4) in an attempt to address this question. "Water levels measured in capture wells represent pumping water levels, or levels measured during some portion of "recovery" when pumps have turned off. Water levels inside a pumping are often lower than those in the surround formation due to frictional losses caused by drilling and well completion processes. Well construction frictional losses vary from well to well and with operation of wells over time. Therefore water levels used for potentiometric map construction represent an estimate of actual conditions".

As per third paragraph in "iii. a": Shallow units include alluvium, shallow overburden bedrock, Rosebud Coal, and spoil. Each of the units flow laterally into the adjacent material making mapping as a single unit appropriate. Shallow bedrock only exists in a small area in the southern portion of the Plant Site. The shallow bedrock is bound on all sides by unconsolidated deposits so groundwater, if present, flows into these units forming a single surface. Approximate boundaries of the different deposits has been delineated on the shallow maps. Note that the contact between the spoil limits map and well construction map vary slightly. This is a function of well location and completion in relation to the adjacent spoil (the upper portion of the well may have penetrated dry spoil before entering deeper bedrock units).

As per fourth paragraph in "iii. a": At the time of the preparation of the site history report (December 2012) there were not enough data to construct meaningful maps for the sub-McKay strata. Additional wells have been installed since that time and although data in the sub-McKay are still limited, maps have been added to the report.

As per fifth paragraph in "iii. a": Text has been added to the report: The shift in the hydrologic divide is believed to be a function increases in water levels in spoil to the east, and from dewatering on the plant site. Groundwater levels in spoil tend to recover relatively slowly after mining and reclamation are complete.

As per sixth paragraph in "iii. a": Groundwater flow is generally accepted to be perpendicular to potentiometric contour lines. Anisotropy and heterogenieites may alter these flow paths on a small scale. An example would be an open fracture oriented perpendicular to the direction of groundwater flow. Groundwater would tend to spread out along the fracture until a pathway is found to flow downgradient. Porous groundwater flow and flow in secondary porosity oriented in the direction of groundwater flow, however, tend to maintain the overall flow direction. However, on a larger scale, the overall flow directions predicted by the potentiometric maps generally hold true. In addition, groundwater flow directions depicted on the shallow and McKay maps are considered accurate due to the high number of monitoring points available. A clear hydrologic divide is exhibited on the potentiometric map for the shallow interval as depicted by flow arrow pointing in opposite directions on adjacent contour lines. There are insufficient data to the southeast to identify a divide in this area for the McKay and Sub-McKay units.

As per seventh paragraph in "Comment iii. a": Groundwater data are sparse on the eastern side of the Plant Site, particularly in the spoil area. However, there are sufficient data to interpret groundwater flow directions to the southeast. An additional point of evidence is an old mining cut located beside Drain Pit #3. This drain pit (located under and directly east of the WECO sediment pond along the eastern boundary of the Plant Site). This mining cut extended through the Rosebud Coal and is therefore at the lower boundary of the spoil. Groundwater issues at this point. The ground surface near the well DP3-696R is 3240 feet above MSL. This level is above the floor of the cut. So the groundwater level at this location is less than 3240 foot elevation, much lower than levels measured in the eastern portion of the Plant Site near the Units 3 & 4 Bottom Ash Ponds, the WECO Sediment Pond, and the Units 3 & 4 Wash Tray Pond.

As per eighth paragraph in "As per seventh paragraph in "Comment iii. a": A sentence describing the regional flow of groundwater in the Fort Union Formation, as suggested by Wayne Van Voast, has been added to the report along with a reference.

Comment:

b. Vertical hydraulic gradients

DEQ requests that PPLM include "water level difference maps" or water-difference tables showing vertical head differences between monitoring wells completed in different aquifers. Please include the following maps or tables: spoil-sub McKay; spoil-McKay; spoil-interburden; McKay-interburden; McKay-sub McKay; alluvium/colluvium-sub McKay; alluvium/colluvium-McKay; alluvium/colluvium-interburden. Water level data should be chosen from pairs of wells near each other. If possible, DEQ suggests using colored areas on the maps to distinguish

between different value ranges of vertical gradient. PPLM may choose to put this information on a preexisting map such as Figures 3-8 and 3-9.

If there are not enough data to present on maps, DEQ requests that the values of water level differences and calculated vertical gradients for the Plant Site area be presented in a table as well as the name of the well pairs, the dates of the water level measurements, and the Plant site subarea where the well pairs are located (see the discussion concerning Section 3.6).

DEQ requests that PPLM discuss the evidence for vertical hydraulic gradients in the Plant Site Area. Please specify the areas where vertical gradients are present. Please discuss how the use of long well screens in the wells (used to maximize yield) does make numerical estimates of the gradients uncertain.

DEQ requests that PPLM discus the seasonal and long-term changes observed in the vertical hydraulic gradients, particularly in the shallow units. In particular, please discuss the observed changes in vertical gradient for the geologic units near the East Fork of Armells Creek.

DEQ requests that maps showing horizontal and vertical gradients with arrows for projected horizontal flow directions be constructed separately for the area aquifers and be included in the report.

Response: A figure showing water levels over time for "nested" or nearly nested wells has been added to the report as Figure 3-18 to demonstrate vertical gradients at various places around the Plant Site. Hydrographs were used in lieu of the table requested by MDEQ and "water level difference maps" and tables. Use of the hydrographs allow the difference in water levels between intervals to be visually and quantitatively be examined over extended time periods.

"Horizontal" gradients, or the actual groundwater gradient for individual units is demonstrated by potentiometric maps already included in the report. Groundwater flow is perpendicular to the potentiometric contours in a down-gradient (higher elevations to lower elevations) direction. However, as requested by MDEQ, an additional potentiometric map has been added for the sub-McKay interval. Examination of the figure referenced in the proceeding paragraph shows that vertical gradients are typically downward. If the groundwater gradient is down, then the vertical gradient at that given point will be downward.

Maps that demonstrate groundwater flow directions are also shown in the groundwater model report contained in Appendix A.

Comment:

c. Hydrogeologic parameters

DEQ requests that PPLM explicitly state the range of hydraulic conductivities and storativities for each geological material described in section 3-4 (alluvium, colluvium, Rosebud overburden, Rosebud Coal, Clinker, Spoil, Interburden, McKay Coal), derived from the aquifer tests listed in Appendix A of the Plant Site Groundwater Model Report. If values from aquifer tests are not available, DEQ requests that PPLM state this in Section 3.4. Please state if any estimates of hydrogeologic parameters for the geological units have been used in the Plant Site Report.

Response: The following table is from the groundwater model report – Appendix A

Table 2. Summary of Aquifer Properties by Hydrostratigraphic Unit.

Hydro Stratigraphic Unit	Geometric Mean Transmissivity (ft2/day)	Geometric Mean Hydraulic Conductivity (ft/day)	Minimum Hydraulic Conductivity (ft/day)	Maximum Hydraulic Conductivity (ft/day)	Geometric Mean Saturated Thickness (ft)	Geometric Mean Storativity
Alluvium	225	18.3	0.15	355	12	0.0003
Plant Spoils	111	7.5	0.01	622	16	NA
Rosebud	149	12.5	0.9	65	12	NA
Interburden	13	1.1	0.02	39	13	NA
McKay	26	2.3	0.06	9.3	10	NA
Sub McKay	41.5	2.5	0.03	242	14.1	0.0008

From Newfields, 2015 Groundwater Model Report that will be Appendix A of the report.

Comment:

d. Simplified Conceptual Groundwater Model

DEQ is requesting the addition of a detailed conceptual model in the Plant Site Groundwater Model Report. For the Plant Site Report, DEQ requests that PPL include a simplified model in Section 3.4.3. Based on the current and requested discussion, maps, and tables, please discuss:

1) **How the geologic units are organized into hydrogeologic units based on depth, amount of water storage, transmission of water, and similarity of physical characteristics.**
2) **The general discussion of groundwater flow in the hydrogeologic units.**
3) **The degree of flow between hydrogeologic units (e.g. confinement versus unconfinement).**
4) **The important boundaries in the model and the nature of these boundaries.**

DEQ requests that PPL prepare and include diagrams showing visualizations of the hydrogeologic units suitable for the interested general public. DEQ suggests that diagrams using plan view, cross-section view, oblique block diagram, or exploded view of separate hydrogeologic units may be appropriate to use.

Response: A detailed conceptual model is contained in the groundwater model report of Appendix A. A simplified conceptual model has been added to the Plant Site Report. However, to avoid redundancy and confusion, figures concerning various aspects of the conceptual model have not been included in the Plant Site Report. Instead the model report is referenced for figures illustrating the various concenpts.

Comment:

6. **Section 3.5 Description of Completed and Ongoing Remedial Actions**

   In the first paragraph of Section 3.5, PPLM mentions "best management practices". DEQ requests that PPLM define this term. DEQ requests PPLM discuss in detail examples of best management practices in the subsections of Section 3.5.

Response: Section 3.5 has been reformatted to better describe best management practices.

Comment:

1. **Section 3.5.1 Operational Monitoring**

   DEQ requests that PPLM incorporate sufficient information from the current Water Resources Monitoring Plan to document the requests by DEQ concerning this section (Comment #11 by the contractor).

Comment 11. Section 3.5.1. A table and figure summarizing PPLM Water Resources Monitoring Plan should be included in the Plant Site Report to aid in understanding the operational monitoring approach.

DEQ defines monitoring activities as both water quality sampling and the measurement of water levels.

In the first paragraph, PPLM discusses the sampling frequency of wells. DEQ requests that PPLM discuss how the monitoring frequency for monitoring wells is determined and why the majority of monitoring wells are sampled twice a year.

DEQ requests that PPLM discuss the details concerning the differences between monitoring and capture well monitoring including frequency of monitoring. Details concerning capture well monitoring are discussed in the second paragraph of the response by PPLM to Comment #19 by the contractor. DEQ requests that PPLM incorporate the language of this response into the section discussion.

Response: *PPL Montana submitted its latest version (Revision 5) of Water Resources Monitoring Plan to DEQ on September 12, 2011. A copy of the monitoring plan is included as Appendix E. Text has been added to Section 3.5.1 to address the questions above.*

[KS1]

In any year, not all of the monitoring and capture wells are monitored. Please discuss the general methodology used to decide if a well is to be monitored in a given year or the monitoring frequency for the wells is to be altered.

Response: The following text has been added to the report "Wells that are considered critical for detection monitoring or to evaluate current water quality conditions are generally monitored twice a year. Less frequent monitoring is conducted on wells that have been installed for specific investigational purposes but are not critical for the overall evaluation of an area, typically because of the high density of wells. An example is wells identified as AB-# that were installed around the former Units 1&2 AB Pond, an area considered as a former source for process water seepage. The majority of these wells still exist around and between the Units 1 and 2 A Pond and B Pond. These wells are monitored for water quality on a three year basis which allow changes in water quality below and very near these ponds to be evaluated. An extensive network of monitoring wells and capture wells are present down gradient of the ponds to detect, mitigate, and characterize conditions."

In the first paragraph or a new paragraph, DEQ requests that PPLM discuss the methodology for the following decisions: 1) the decision to convert a monitoring well to a capture well; 2) the decision to shut down a capture

well; 3) the decision to reactivate a capture well. Please incorporate the relevant language from the response by PPLM to Comment #19 by the contractor

Response: Text has been added to a new section "Capture System Monitoring"and includes information requested above.

In the second paragraph, DEQ requests that PPLM discuss the rationale for the common parameter list described in the text. DEQ requests that PPLM describe the historical decisions that were made that resulted in the list.

The responses by DEQ to Comment #19 of the contractor are incorporated into the previously discussed requests for changes. Please incorporate all relevant details from the current Water Resources Monitoring Plan to address these requests.

Comment 19. Section 6.0. Bullet 1 and Page 6-3, Bullet 2. The recommendation to consider periodic shutdown of groundwater capture wells showing improvement requires further information. Please provide what PPLM considers an "improvement". Also, please provide the sampling frequency and parameters that PPLM proposes to review prior to recommending any well for shut down.

Response: From MDEQ subcontractor, Comment 19.

Groundwater quality that has declined below what is considered baseline levels and/or background screening levels established by statistical analysis previously conducted for the site. Long term water quality trends will be evaluated to verify that wells have returned to levels observed prior to initiating capture. These criteria will be further refined in the next phase of the AOC process concerning corrective action.

Capture wells are routinely monitored two to three times per month for operation, water levels, and pumping rate. Field specific conductance is measured monthly. In addition, water quality samples are collected and submitted for laboratory analysis twice a year. Samples submitted for laboratory analysis are analyzed for PPL's standard list of analytes. These data (field and laboratory) will be reviewed prior to shutting down any capture well. Any capture wells that are shut down will continue to be monitored for SC on a monthly basis and sampled for laboratory analysis twice a year. Pumping will be resumed if data indicate worsening water quality.

In the third paragraph of page 3-39, DEQ requests that PPLM add that the pond water quality samples are almost all surface samples, not samples taken at depth in the ponds. Please discuss if samples are taken from the same location in each pond every year or not. Please state which ponds are

annually sampled and which ponds are sampled every three years and the rationale for the pond sampling frequency. In the second sentence of the third paragraph, DEQ assumes that "raw water from the supply pipeline" means fly ash slurry in the pipeline from the plant. Otherwise this phrase means clear water returning to the plant in a pipeline from the ponds. DEQ requests that the nature of the sample be clearly described. In either case, please explain why the sample is taken and analyzed. DEQ requests that PPLM discuss the rationale for the surface water parameters list described in the text.

Response: Text has been added to the report to address this comment. In general, surface water samples are collected from the surface as opposed to depth samples or depth integrated samples. Samples are collected at the same approximate location during each event unless the surface of the pond has moved due to ash placement, if access to the area changes, or if access to an area becomes unsafe due to climatic or operational conditions.

Raw water from the supply line means water that is being pumped from the Surge Pond to the plant for use. Water in the Surge Pond is pumped from the Yellowstone River at Nicol. Raw water has not been treated for use in boilers. Samples of raw water are taken to evaluate the chemical profile of the water.

In the fourth paragraph, DEQ requests that PPLM correct the number of sites where samples were collected during the synoptic runs. According to the 2011, 2012, and 2013 synoptic run final reports, at least 12 sites on East Fork Armells Creek were sampled. In addition, 1 tributary site and 1 treated sewage effluent pond site were sampled in 2012 and 2013. DEQ does acknowledge that over the 14-year duration of the synoptic sampling that more sites have been added. DEQ requests that discuss the rationale for the surface water and groundwater parameter lists used during synoptic sampling and described in the text. DEQ requests that PPLM describe the historical decisions for the lists.

Response: The statement that samples are collected from five sites on East Fork Armells Creek during the synoptic run within the AOC Plant Site boundary, is correct. However, this statement has been revised to read. "In 2014, samples were collected from 12 locations along East Fork Armells Creek, five of which are within the AOC Plant Site boundary". Other information requested in the above comment has been added to the text.

DEQ requests that PPLM add a new paragraph describing the details concerning water level monitoring, including frequency and schedule, and incorporating relevant information from the current Water Resources Monitoring Plan. Please explain how the "defined set of wells" is determined for which monthly monitoring occurs. Please explain how the "expanded list" of wells is determined for which water levels are measured twice a year. Please explain how and why water levels at capture wells and "select monitoring wells in the vicinity of the capture wells" are measured monthly. (The quoted phrases are from the PPLM response to Comment #20 by the contractor.) Please discuss the frequency of measurement and the rationale for the frequency for the piezometers in the Plant Site Area. The requests by DEQ concerning details of water level measurements are the response by DEQ to Comment #20 by the contractor.

Response: The following response is a revision of Comment #20 from HydroSolutions as referenced in the previous paragraph. Water levels are measured on a monthly frequency from a defined set of wells. Wells monitored at this frequency are defined in the PPLM Water Resources Monitoring Plan (PPLM, 2011). Additionally, an expanded list is measured twice a year. Wells measured at a frequency of less than monthly are in less critical areas or are in areas that have a high density of wells. Further, water levels are routinely monitored in groundwater pumping wells and select monitoring wells in the vicinity of the capture wells. Several piezometers in the Units 1 and 2 A pond and B Pond area are monitored once every three years, at a minimum. These piezometers are located around the perimeter of ponds and the lower frequency of monitoring is used to obtain data to evaluate long-term trends at the site. Frequency for monitoring is defined in the Water Resources Monitoring Plan (PPL, September 2011). See Comment 11.

Concerning Table 2-2, DEQ has requested current and historical documentation concerning the detection and reporting limits for Pond samples. DEQ also requests the same information concerning the stream and groundwater samples in the Plant Site Area. Please note that DEQ will make similar requests in both the Units 1 & 2 and Units 3 & 4 Site Reports.

Response: See response to comment #4 for section 2.2.1

Comment:

2. 3.5.2 Groundwater Mitigation Activities

DEQ requests that PPLM document the typical frequency of measurement of flow rate, water level, and specific conductance for capture wells. Please

indicate if these periodic water level measurements are used to determine the potentiometric surface elevation at the wells.

Response: Capture wells are monitored one to three times per month. During these visits, the flow rate is measured. Flow rates are typically measured near the wellhead using a volumetric methods. That is, a valve is opened near the well and water is directed to a calibrated bucket. The time to fill the bucket is measured and a flow rate calculated. The SC of the water is measured in the pumped water. This flow rate is considered consistent until the next monitoring event. Hour meters are installed at each capture well. Hour meter readings are recorded during each visit. The pumping time between visits is calculated and multiplied times the flow rate to calculate gallons pumped between visits. Note that this method of measurement may overestimate the amount of water actually pumped. This is caused by head differentials at the discharge point during normal pumping and those that occur at the well head during flow measurement. For example, back pressure may occur in a discharge pipeline if a substantial amount of scale buildup occurs, if the discharge point is at a higher elevation than the well, if multiple wells use the same pipeline filling it to capacity, if air-locking occurs, or if flow regulating valves or check valves create restrictions to flow. Under these conditions, flows measured at the wellhead will be higher than the actual amount coming out of the end of the pipe. This is because the pressure that the submersible pump has to overcome is greater in the actual pipeline than the pressure at the end of the hose used in volumetric flow measurement.

Water levels are measured in each pumping well during each site visit using calibrated electronic water level meters. Potentiometric maps are constructed using a combination of static and pumping water levels. Note that pumping water levels are an approximation of actual water levels that are present in the formation immediately outside of the wells since well losses and formation losses are not accounted for. In addition, water levels are measured at various time during capture well pumping cycles (pump on at full drawdown, pump off and water levels recovering, pump on and water levels being drawn down, etc.). Maps are prepared by plotting the calculated water level elevations for particular intervals (Shallow, McKay, Sub-McKay, etc.) on map. A contouring program is used to prepare a preliminary map. The computer generated map is then reviewed and revised based on professional judgement and site knowledge.

SC is measured during the majority of site visits. SC is typically measured in water pumped from the well while measuring pumping rates. However, in some cases, insufficient water may be available to obtain and SC measurement. In these cases, a SC probe may be lowered into a well to obtain a measurement.

DEQ requests that PPLM discuss what events start and stop pump operation in capture wells. Please document the typical range of hours operated per time period (day or month) for the Plant Site capture wells.

Response: The vast majority of the wells at the site are operated with pump controllers that react to electrical currents to turn pumps off. If water levels in a well drop to the point of cavitation (sucking air), the electrical current will increase (since the pump rotates more freely when air enters) causing the pump controller to shut the pump off. Similarly, if something foreign enters a well (sediment for example), the pump will create a greater electrical draw and the controller may turn the pump off. Pump controllers have a timer that can be set to turn the pump back on. The time interval is set depending on previous observations of pump cycling at a well and well yield. Controllers for wells that have shown frequent cycling (typically low yield wells) are typically set with longer start intervals. This is because the water level in the well recovers slowly. Higher yield wells are programmed with shorter start intervals. Adjustment of the pump cycling maximizes the amount of water captured, minimizes pump wear, and maintains lower water levels near the well.

Pumps are wired to run around the clock. However, because of variations in well yield, the amount of time varies substantially from well to well. Low yield wells may only run a few minutes a day while higher yield wells may run continuously.

DEQ requests that PPLM provide more documentation concerning capture (pumping) rate statistics for the capture well network at the Plant Site area including the range of values of average monthly capture rate as well as seasonal variation of capture rate. DEQ requests that the average capture well rates be added to Table 3-2; please specify how these capture rates were determined (e.g. "average yearly capture rate").

Response: The requested information has been added to the table, as requested.

DEQ requests that PPLM summarize the current capture rates for the other underdrain systems besides Units 1 & 2 B Pond Between Liner.

Response: The capture rates for the underdrain systems for the B Pond has been added to the text of the report.

DEQ requests that PPLM summarize the longer-term area average capture rate statistics besides August 2012. Please include the yearly area statistics for 2011, 2012, and 2013. Please also discuss changes to yearly capture rates as the number of capture wells changes. DEQ acknowledges that capture rate statistics will likely vary with changes in precipitation and changes in pond water management. DEQ requests that PPLM present area average

capture rate statistics for the last 5 and 10 years, noting any factors such as those discussed which might be affecting the statistics.

Response: Annual pumping rates for 2011, 2012, and 2013 have been added to Table 3-3.

DEQ requests that some long-term statistics also be cited for individual capture systems. DEQ requests that PPLM summarize the yearly capture statistics for some of the capture wells west of the ponds (e.g. 82A, 75A, 78A, SRP-5, 91S, 108A, SRP-8, 106a, 10S, 68A) for each of the last five years. DEQ requests that long-term statistics be presented for the underdrain systems for each of the last five years.

Response: The requests in the above comments for Section 3.5.2 are redundant. For this reason, the information requested by MDEQ has been added to a single table. Table 3-4has been revised and reformatted to include this information.

Comment:

3. **Section 3.5.3 Completed Plant Site Mitigation Measures**

DEQ requests that PPLM explicitly define what "mitigation measures" means in this section. DEQ requests that PPLM state if the cited measures involve changes to ponds or pond drain systems, not changes to the monitoring/capture well network.

DEQ requests that PPLM explain the significance of the described mitigation measures. DEQ requests that PPLM explicitly state whether these measures form a complete list of all measures completed in the Plant Site Area or form the group of measures that have had or will have the most impact on groundwater remediation.

Please cite the time range when the described mitigation measures occurred.

For each mitigation measure, please cite the appropriate reports in the text as listed in Table 3-1. DEQ is unable to find the report concerning the relining of the 1 & 2 Bottom Ash Clearwell and installation of an underdrain system in 2006.

The assessment of the effectiveness of all of the mitigation measures except the relining of the 1 & 2 Bottom Ash Clearwell is described in Section 3.6. Please include an assessment of the relining of the clearwell in Section 3.6.4, Units 1 &2 A/B Flyash Pond Area.

Response: Comment noted and addressed. An electronic copy of the report is included with this submittal.

Comment:

4. **Section 3.5.4 Planned Plant Site Activities**

Please change the first sentence of the first paragraph to "PPLM continues to improve best management practices, training, and facility upgrades to improve environmental conditions near the Plant Site, to aid in groundwater mitigation efforts, and to help reduce the potential of compounding existing problems or creating new problems in the future." The corrected first sentence is PPLM's response to Comment #13 by the contractor.

Response: Comment notedand addressed

Comment:

DEQ is unsure as to what is the specific purpose of Section 3.5.4. Please address in writing the following issues:

1. **The time frame of the listed activities is not given. DEQ requests some indication from PPLM as to whether the planned activities are in the next few years or sometime in the indefinite future.**
2. **DEQ requests that PPLM explain why these particular activities were listed. Please indicate if in the judgment of the PPLM staff, these activities are the most important to do or consider.**
3. **All of the listed activities involve ponds. There are no activities involving wells. Possibly planning involving wells is located in other sections of the site report such as Section 5.0 or 6.0. DEQ requests that PPLM explain why there are no planned well activities in Section 3.5.4.**

For reference to past work, DEQ requests that PPLM refer to the relevant investigations or reports as listed in Table 3-1.

Response: Section 3.5.4 provides additional site activities that are planned but have not been scheduled. These actions will aid with water management and mitigation of groundwater *impacts. A Remedy Evaluation Report will be prepared as a second phase of the AOC process. This report will define timelines, activities, and methods that will be implemented at the site.*

Comment:

a. **First bullet**

DEQ requests that PPLM clarify the nature of the investigations in the Units 3 & 4 Wash Tray Pond area that revealed the presence of soluble constituents in the area.

Response: The pond was visually examinde and fly ash was observed in the pond. Samples were collected of pore water following a period of high precipitation which resulted in the bottom of the pond being covered with runoff water. Samples were collected at multiple locations by advancing a small diameter probe into the sediment at the edge of the pond. The probe was advanced at a 45 degree angle and extended approximately two to three feet under the water. Water samples were collected and submitted for laboratory analysis. A sample from the surface of the pond was also collected and analyzed. Results of the analysis showed higher concentrations of dissolved materials in the pore water samples than in the pond sample indicating the likelihood of soluble materials on the pond bottom. Well 112R was installed to provide additional monitoring at the northwest (downgradient) corner of the pond.

Text has been revised to indicate that pore water samples were collected.

Please summarize the evidence whether or not leaching from the remaining solids in the Units 3 & 4 Wash Tray Pond is impacting or has impacted the groundwater outside of the pond.

Please join the last complete sentence in the paragraph "However, options include leaving a depression to collect clean water to provide a recharge source near the center of the former pond location." with the incomplete phrases that follows.

Response: Editorial comment noted. As indicated in the previous response, well 112R was installed at the northwest edge of the pond to provide additional monitoring immediately down gradient of the pond. Although some indicator parameters exceed BSL's the overall nature of the water does not appear to be impacted by the process pond. Additional monitoring are needed to further evaluate conditions at this well.

Additional text has been added to the report explaining addition study at the Units 3&4 Bottom Ash Pond. Current plans are to remove the flyash from the pond bottom.

Comment:

b. Second bullet

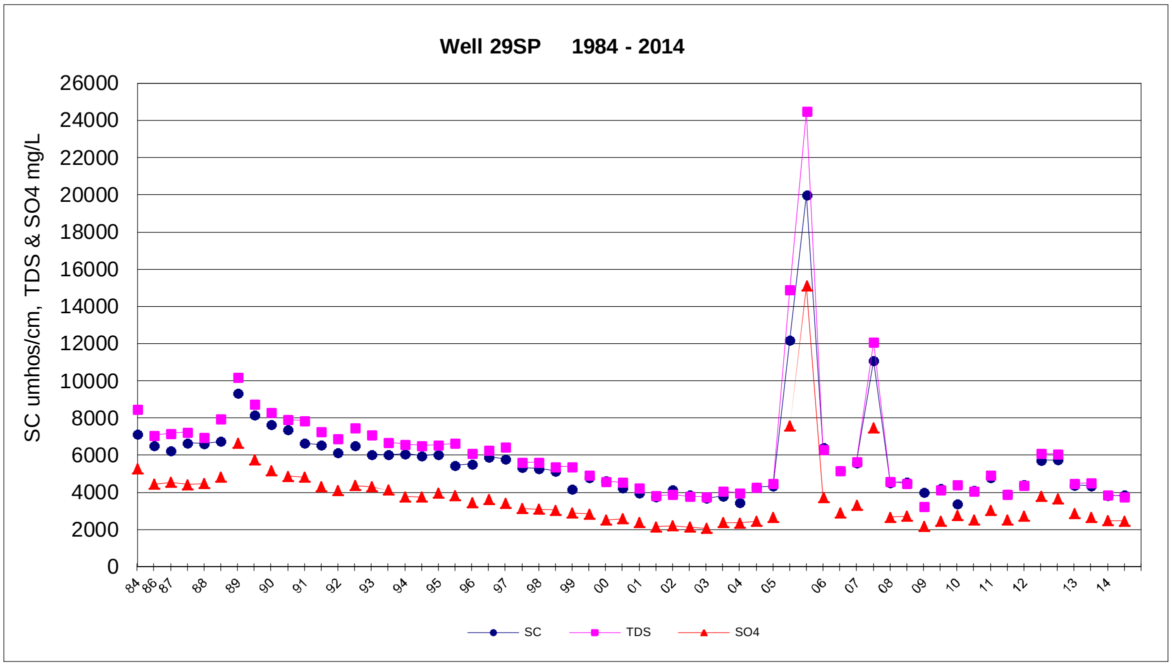
Please change the names so as to be consistent with Figure 2-1, and in Table 2-1.

DEQ requests that PPLM explain to what depth were the solids removed from "below the former D4 Brine Pond". Please explain the criteria used to assess how much material was removed (both surficial area and depth), which areas were excavated, and which areas were not excavated.

Please specify what "field operations" were conducted by PPLM that found evidence for elevated salts in the soil. Please summarize the evidence from specific wells that "soil containing elevated levels of salt remains in the area". Please summarize the evidence that the previously mentioned specific wells were not impacted by process pond water from neighboring areas with slurry-filled ponds as compared to leaching from salt-laden soils in the Brine Pond area.

Response: Reference to this pond has been revised to read "former D4 Pond", consistent with Table 2-1. Text under bullet 2 has also been revised to reflect additional work that has been conducted in the area since the Plant Site History AOC report was first issued in December 2012. The work under this bullet is no longer planned but has been completed. Investigation of the area was summarized in the report "Former D4 Brine Pond Geoprobe Investigation PPL Montana LLC, Colstrip Steam Electric Station "(Hydrometrics, Inc. July 2013). *PPL removed soil from this area in the fall of 2014 and transported it to the Units 3&4 EHP. A final report of the soil removal has not been completed as of this writing.*

Abrupt increases in levels of conductivity were observed following the D4 liner breach. Water quality in nearby monitoring and capture wells was improving at the time of the breach. A water quality chart for well 29SP showing SC, TDS, and SO4 over time is shown below as an example. Well 29SP is south of the former brine pond area and is currently a capture well. Water at well 29SP showed possible impacts in the late 1980's when influences from the D3 Pond liner tear became apparent. Groundwater capture wells B-1 through B-5 were installed and gradual water quality improvement was observed. Water quality leveled out at near background levels about 2001 and remained relatively constant until November 2005, following the D4 liner tear. Additional groundwater capture (including conversion of well 29SP) was installed in the area and water quality rapidly improved. Precipitation in 2011 and 2012 resulted in ponded water in the depression left following the removal of D4 Pond. Increases in SC observed at 29SP are in response to salts being mobilized by the precipitation. The low levels of SC observed between *the peaks are evidence that the groundwater near 29SP is not currently influenced by other sources.*



Comment:

c. Third bullet

DEQ requests that PPLM summarize the evidence that the remaining fly ash on the pond bottom may be a source of contamination for groundwater.

Please specify what future activities are planned by PPLM to evaluate the fly ash on the pond bottom.

DEQ requests that PPLM explain in the fifth sentence the use of the word "thereafter". The use of the word implies that the described changes in water management will occur after some event or decision. Please specify the event or decision.

Response: As indicated in Table 3-2 (formerly Table 3-1) pond bottom samples were collected in 2009 to evaluate if the material on the pond bottom contained material that would be mobilized by water moving through it. Several samples were collected during the investigation and composited into a single sample. This composite sample was submitted to an analytical laboratory for analysis using saturated paste methods. Analytical results showed 233 mg/L chloride, 4,700 mg/L sulfate, 13.8 mg/L boron and a specific conductance of 5,890 µmhos/cm suggesting *mobile salts were present in the material collected from the pond bottom. Plans are to removed the flyash from the bottom of the pond.*

The text in the report has been revised to reflect the above information and to clarify the use of the word "thereafter".

Comment:

d. **Fifth bullet**

Please change the pond name so as to be consistent with Figure 2-1, and in Table 2-1. DEQ presumes based on the reference to catching runoff from coal piles that this pond may be Units 3 & 4 Drain Collection Pond (Figure 2-1) which may correspond to the Units 3 & 4 Scrubber Drain Collection Pond (Table 2-1). Unfortunately the name on Figure 2-1 does not correspond to a pond name on Table 2-1.

Please summarize the evidence concerning leakage or the lack of leakage from the pond.

In the last sentence, please add the word "the" after the word "change".

Response: The word "Scrubber" has been added to Figure 2-1 to clarify the pond as the Units 3&4 Scrubber Drain Collection Pond.

This pond is lined and only receives water from storm water runoff. The pond is not used as a process pond so leakage of process water is not occurring at this location.

Edit in last sentence noted.

Comment:

e. **Sixth bullet**

DEQ presumes that "C" pond is North and South Cooling Tower Blowdown Ponds C located in the southernmost portion of the Plant Site. Please change the name so as to be consistent with the names on Figure 2-1 and Table 2-1.

Please explain how and where flyash slurry enters the ponds and how storm water from the ditches enters the ponds.

Please explain why PPLM writes that the storm water "provides an outer barrier of better quality water". DEQ requests that PPLM summarize the evidence supporting the presence of a barrier.

Response: First comment noted. The text following this bullet has been revised by adding the following to address the first and third comment under e. Sixth Bullet: "Pond C – Now comprised of the North and South Cooling Tower Blowdown ponds, these ponds are also referred to as the Units 1&2 Cooling Tower Blowdown ponds. The original pond was divided into a North Pond C and South Pond C in 1987. Storm water, collected in the Plant Site ditches is currently pumped to north and south cells. This provides an area of potential recharge to groundwater of better quality water since the ponds are downgradient of areas of known impacts. Water levels in the pond are above the level of the local groundwater so a downward vertical gradient exists. Slight mounding, as indicated by wider spacing of shallow water table contours lines (Figure 3-15), is apparent in the potentiometric map associated with the ponds".

Flyash is not directed to the pond in dry form, as scrubber slurry, or as paste. Storm water collected in the Units 1-4 Sediment Retention Pond is pumped to the ponds. Raw water is also sometime directed to the pond via pipeline.

Comment:

f. Seventh bullet

DEQ is not sure what the "North Drain Pond" corresponds to on Figure 2-1 and Table 2-1. Please change the names in the text so as to be consistent with Figure 2-1 and Table 2-1.

Please summarize the evidence to support the statement "There are currently no indications of seepage or leakage from this pond."

*Response: Comment noted. The is also referred to as the North Drain Pond or North Pond***.**

Water quality in the Units 3&4 North Plant Area Drain Pond has been highly variable. The following ranges of concentrations for indicator parameters have been reported in water collected in the pond between 1996 and 2012: SC 1740 to 4730 umhos/cm; sulfate 477 to 2560 mg/L, boron 0.4 to 1.9 mg/L, calcium:magnesium typically greater than 2, and chloride of 71 to 439 mg/L. Well 24S is completed in the first water encountered and is located downgradient of the pond. Since 1996, SC has been consistently above 4000 umhos/cm while only one sample from the pond has exceeded this value. Sulfate levels in groundwater from well 24S have averaged 2450 mg/L since 1996 while the Units 3 & 4 North Plant Area Drain Pond water has averaged less than 1500 mg/L with only one sample exceeding the average observed at 24S. Dissolved boron concentrations in groundwater from well 24S have been consistent thoughout *the monitoring period ranging from 1.0 to 1.5 mg/L. Chloride concentrations in water from well 24S have shown a slight increasing trend throughout the monitoring period. However, without the presence of consistent increases of SC and sulfate, it is unlikely that the increases are due to the Units 3&4 North Plant Area Drain Pond. Note that this pond is very small and holds minimal amounts of water. Water that does enter this pond (raw water filter backwash, north plant area drainage, and overflow from the 3&4 Cooling Towers) is pumped into the bottom ash system or the circulating water system. Hydraulic head on top of the HDPE liner is reduced by limiting the amount of water in the pond further minimizing any potential for seepage.*

Comment:

g. **Eighth bullet**

Please change the name in the text so as to be consistent with Figure 2-1 and Table 2-1.

Please summarize the evidence to support the statement "Currently there is no evidence of leakage that would result in environmental impacts".

Response: Comment noted regarding pond nomenclature.

There is currently not any groundwater monitoring wells directly downgradient of the Units 3&4 North Plant Sediment Pond. However, there is not visual evidence of leakage such as plant die off or monoculture formation. The water quality in the pond is generally better than background shallow groundwater quality. For example, water quality samples have been collected from the pond once every three years since 1993. Samples analyzed during that time have had reported ranges of concentrations as follows; SC 619 to 1320 umhos/cm; sulfate 119 to 479 mg/L; boron 0.2 to 0.6 mg/L and chloride 38 to 98 mg/L. Based on these data, any leakage from the pond would likely improve the receiving groundwater.

The text has been revised to include water quality ranges for the pond as described above have been incorporated into the text.

Comment:

h. **Ninth bullet**

Please change the name in the text so as to be consistent with Figure 2-1, and Table 2-1.

Please summarize the evidence concerning leakage or the lack of leakage from the pond.

Response: Comment noted. Text revised as requested to summarize leakage or lack of leakage from the pond.

Comment:

i. **Tenth bullet**

Please change the name in the text so as to be consistent with Figure 2-1 and Table 2-1.

Please summarize the evidence concerning liner damage and the need for liner repair. If the liner was replaced in 2013, please cite the written report. Otherwise, please indicate if the work is ongoing or being planned.

Response: Comment noted and the text has been changed as requested. Visual examination of the liner indicated damage. The pond Units 3&4 Scrubber Auxillary Drain Pond has been rebuilt using concrete..

Comment:

j. **Section 3.6 Effectiveness Assessment of Remedial Action**

a. **DEQ requests that PPLM change the first sentence of the first paragraph, "Water quality, containment, and source area control are three indicators of the effectiveness of remedial actions." Changes in water quality are indicators of effectiveness, but containment and source area control are actions that may lead to indications that remedial action has been effective.**

Response: The wording has been changed as requested.

Comment:

b. **DEQ requests that PPLM justify the use of the specific conductance values as the criterion to assess effectiveness of remedial actions. Typical groundwater compositions in the Plant Site area indicate that sulfate is usually the most abundant of the major cations and anions and has a major, often predominant, influence on specific conductance. Specific conductance values are also influenced by concentrations of the abundant ions including magnesium, calcium, sodium, potassium, and bicarbonate. The concentrations of the other indicator parameters, chloride and boron, are so much lower than sulfate concentrations that chloride and boron concentration have only minor influences on the specific conductance value. As shown in Figures 3-11 to 3-15 inclusive, the variation of sulfate composition with time parallels the variation**

of specific conductance, while the variation of chloride and boron can show different patterns. In groundwater, sulfate is subject to geochemical reactions including reactions with minerals in the aquifers. By contrast, chloride and boron are relatively conservative parameters.

DEQ requests that PPLM evaluate the effectiveness of remedial actions using all four of the indicator parameters. DEQ requests that for continuity, PPLM only use the four designated indicator parameters in the discussion of section 3.6. DEQ requests that the references to TDS (total dissolved solids) be removed in Sections 3.64 and 3.65 (pages 3-55 and 3-57) and substituted with references to specific conductance. DEQ does acknowledge that TDS is very likely to vary in a similar fashion as specific conductance.

Response: It is agreed that sulfate is the major anion present and concentrations of sulfate vary closely with SC. As indicated SC is also affected by other cations and anions present in the water. Also it is agreed that chloride and boron are more conservative than SC and that there are a few limited areas of the site where boron and chloride do not co-vary with SC values that are above the BSL. Therefore, all four indicator pararmeters have been, and will continue to be, used in evaluating water quality trends. However, Specific conductance is a good overall field screening indicator of process water for most areas of the site for the reasons listed by MDEQ. SC provides quick indicator of water quality, is easy and accurate to measure in the field, provides an immediate result, and much more data are collected during routine capture system monitoring. Therefore, it provides a useful initial screening in many circumstances.

Chloride and boron are both examined along with SC and sulfate during the investigation process and also when evaluating individual wells. These parameters, along with SC and sulfate are used in the discussion of remedial action effectiveness in Section 3.5 and are included on the time-concentration trend plots. For the areas of the site where SC is below BSLs but chloride and/or boron are above BSLs (i.e. the shallow zone at the 3&4 bottom ash pond and at the 3&4 wash tray pond), SC is no longer discussed and the percent reduction calcuations are based on boron and chloride.

A few water quality graphs have been added to Appendix F. Text has also been revised to discuss trends of some other indicator parameters.

Comment:

c. **DEQ requests that PPLM justify the use of the highest historical SC (specific conductance) measurement compared to recent (2012) values for effectiveness assessment.**

1. **Currently PPLM does not specify the valid date range for the highest SC measurement. In the Plant Site Area, dates of well installation range over three decades. Time series records of SC are very variable in length. In a complex dynamic environment such as the network of wells in the Plant Site Area, factors affecting groundwater quality (and the value of SC) may change during a well's lifetime.**
2. **Currently PPLM does not employ any long-term trend analysis concerning the highest historical SC measurement. Historically wells do show short-period fluctuations in water quality parameters. The highest SC value could have occurred during an historical short-period fluctuation.**
3. **Currently PPLM does not employ any long-term trend analysis concerning the recent SC measurements used in the assessment. There can be short-period fluctuations in recent data. Recent SC values could occur during recent short-period fluctuations.**

Response: As indicated in the previous response, SC is a good indicator of overall water quality. As pointed out by MDEQ in the previous response, SC is strongly influenced by sulfate. It is also strongly influenced in plant site water by magnesium. These parameters are present in relatively high concentrations in all flyash process waters. The highest concentrations of SC are used as a basis for evaluating general water quality. Short term spikes in SC may or may not be related to process water. However, the water evaluated using SC as a basis is from groundwater capture wells. These wells have been converted to groundwater capture wells because they were evaluated as having been, or potentially been, impacted by process waters. Since capture wells are used for the evaluation, it is proper to use the highest values for the well. This may come as a short term peak in levels. However, it is not uncommon for capture wells to experience higher concentrations following startup since groundwater with greater process water impacts is being collected. It is also not uncommon to see rapid decreases in SC when groundwater from un-impacted areas is drawn into the capture wells.

Comment:

d. **DEQ requests that PPLM justify the use of only capture well data for the assessment of remedial action.**

   1. **Captured groundwater is a mixture of natural and contaminated groundwater from sources whose chemical character is not constant in time. Both vertical and horizontal mixing is possible because of the multiple aquifers and site geological complexity.**
   2. **Capture effectiveness is affected by nearby events in the well field such as neighboring pump shutdown and startup.**

3. **Capture of a well is transient as the well pump is turned on and off. Captured groundwater undergoes the transition from laminar to turbulent groundwater flow near the well screen.**

e. **DEQ requests that PPLM include the discussion of effectiveness assessment in the site area monitoring wells as well as the capture wells.**

Response: SC data from capture wells is used because it provides a good indication of overall water quality and associated trends and relatively large volumes of accurate data can be collected during routine operational monitoring. Other data are examined to evaluate groundwater capture well effectiveness. Individual monitoring well data is also examinedfor trends showing increases, decreases, or no change. Additional information is provided in later comment responses using graphs to illustrate various points.

1. *Agreed. It is not possible to capture impacted groundwater without pulling in some un-impacted (natural) groundwater. Drawdown is induced near the capture wells and in the well field so water from different portions of hydrostratigraphic units is collected.*
2. *Agreed, although this is a short-term effect. Longer term pumping results in less effects caused by pump cycling.*
3. *Agreed. Laminar and turbulent flow may occur at the pump intake.*

Comment:

f. **DEQ requests that PPLM comment if the following remedy effectiveness assessment strategies are systematically used at Colstrip:**
   1. **The use of "sentinel wells", monitoring wells down gradient of capture zones that are not currently impacted by process pond water.**
   2. **The use of "down gradient monitoring performance wells", monitoring wells down gradient of capture zones that are currently impacted by process pond water.**
   3. **The use of up gradient monitoring wells in the contamination plumes**
   4. **The comparison of chemical parameters between the three different well types to define the zone of contamination and the effectiveness of remedial action.**
   5. **The use of GIS and geostatistical techniques to help map plume boundaries and plume concentrations.**
   6. **Calculation of contaminant mass concentrations in the plumes and calculation of contaminant mass flux through vertical cross-sections.**

   If one or more of these strategies have been used, DEQ requests that remedy assessment using these strategies be discussed in Section 3.6 and the discussion of remedy assessment in the subareas (Sections 3.61, 3.62,

3.63, 3.64, and 3.65). If PPL plans to use one or more of these strategies during the next phase of the AOC process (Cleanup Criteria/Risk Assessment/Remedy Evaluation), DEQ requests that PPLM discuss the planned implementation in Section 3.6.

Response:

1) Yes, many of the wells installed at the facility were first installed to perform as "sentinel" wells. As time has progressed, some of these wells have been converted to pumping wells for groundwater capture.

2) Yes, there are wells down gradient of current capture systems at the Plant Site. Performance wells may also be viewed as wells within the zone being remediated and may consist of pumping or monitoring wells.

3) There are few true up gradient wells at the site. The furtherst up gradient area would be located along the southeast portion of the site. A groundwater divide is present in this area. Since there is active capture in this area, there cannot be any true up gradient wells. That said, there are wells up gradient of various capture wells that are used to evaluate water quality conditions at thesite.

4) Yes, data from all the monitoring wells is used when evaluating groundwater conditions and effectiveness of groundwater capture.

5) No. A relatively dense network of groundwater monitoring wells exist at the site. Actual data are used to characterize the extent of process water impacts. However, computer software is used to develop concentration contour and potentiometric maps. These maps are then revised based on site hydrogeological conditions and the professional judgment of the reviewer.

6) Mass balance calculations have not been used to evaluate conditions at the site in the sense suggested by MDEQ. Iso-contour maps are periodically reviewed so conditions at various stages in time can be evaluated. Further discussion of methods that will be used to evaluate site conditions and effectiveness of mitigation measures will be included in the Remedial Evaluation. Mass flux calculations can also be performed in the future to further evaluate changes in areas of impacts with time. Preliminary calcluations, not included in the report, have been conducted. These calculations can be made available at a later time or as part of the Remedy Evaluation Report.

Comment:

4. **DEQ requests that PPLM discuss the role of the baseline screening levels in the remedy assessment process. DEQ requests that PPLM discuss the special case when one or more indicator parameters are below the baseline screening levels.**

Response: Baseline screening levels are used as one of the tools to evaluate if concentrations of chemical constituents observed in water quality samples are below levels that can be considered background. Concentrations below the calculated BSL for various units may be indicative of water that is not impacted by process waters. However, other factors are involved when evaluating if process water impacts are present. This includes the longer term monitoring trends, groundwater flow direction in specific areas, and the presence or absence of other indicator parameters. For example, up gradient areas could potentially have waters with chemical concentrations exceeding BSL's, but are not in a location that can be impacted by the Plant Site process water. In this case, the BSL would be exceeded but it would be concluded that there are not any process water impacts.

For the scenario presumed by MDEQ in Comment 'g', it may be common and not a special case that impacted groundwater will exhibit one or more parameters that are below BSL's while some process water impacts still exist. An example would be a water with levels of SC and sulfate above BSL's and also exhibits a low calcium to magnesium ratio, but chloride and boron concentrations below BSL's. In this example, chloride and boron may move more freely through subsurface strata being replaced with water that has lower concentrations. Conversely, chloride and boron may be the first constituents that arrive at a given well, while which concentration of other parameters are still below BSLs. Less conservative constituents, such as sulfate and other common ions, may not move through the system as rapidly and the response to mitigation will be slower. In the case, where concentrations of indicator parameters are not universally below BSL's, additional monitoring will be conducted and mitigation measures continued until it can be concluded, and agreed upon with regulators, that the waters are no longer impacted and water mitigation measures can be reduced or eliminated.

Comment:

H .DEQ requests that PPLM discuss the use of trend analysis of concentration trends in multiple indicator parameters in the remedy assessment process. DEQ requests that PPLM discuss the special cases when: 1) indicator time trends are divergent in time (e.g. Figure 3-11, boron and chloride concentrations for Well 6M and Figure 3-14, boron and chloride concentrations for Well 5S) and 2) indicator time trends that intersect and may form a pair of increasing and decreasing trends (e.g. Figure 3-15, boron and chloride concentrations for Well 45S and 49S).

Response: General response: it is very critical to observe and take note of scales used when multiple parameters are plotted on individual graphs. Former Figure 3-14 is a good example of why this is critical. Concentrations of chloride are shown on the left hand scale with a range of 0 to 400 mg/L while boron is depicted on the right axis with a scale of 0-30 mg/L. Divergence or convergence of may be a matter of scale.

6. 1) Divergent trends, and convergent trends may be indicators of variable source areas, variability's in transport mechanisms, and/or differences in sources. For example, Well 6M well *is completed near old mining spoil, ponds that currently hold storm water runoff, and a closed pond containing residual fly ash. Recharge to the well can be from each of these three sources at different periods in time depending on precipitation, recharge, and groundwater flow. Additional factors, including a periodically used storm water pond south the Cooling Tower Blowdown South Pond periodically contains water which can potentially provide an additional recharge source or create mounding that can change groundwater flow pattern and the source of water flowing to the well. Further, well 6M is a relatively low yield capture well that experiences periodic shutdown and startups. Capture wells also sometimes experience mechanical problems that require maintenance during which time pumps my not be operating. This further changes flow paths. The result of this can be high variations in concentrations of chemical constituents, particularly more mobile ones, such as chloride and boron.*

Well 5S is completed in shallow bedrock with less than 11 feet of siltstone and sandstone separating the completion interval from the alluvium. Divergence in this case is a matter of interpretation as both parameters have shown increasing trends for approximately the same amount of time. During this same time SC and sulfate also increased. These taken as a whole show that more highly impacted groundwater is being pulled to this capture well.

6. 2) The fact that lines representing chloride and boron concentration cross is a matter of scale. However, chloride concentrations are increasing at both wells while boron concentrations are decreasing. This variation is a function of source. The source of chloride is thought to be from a spill of chlorine-based chemicals used in water treatment that occurred at the surface in the area near wells 45S and49S. Overall, water quality has improved due to groundwater pumping in the area.

Comment:

i. DEQ requests that PPLM discuss the relative importance of short-term changes in indicator trends compared to long-term changes in the effectiveness assessment process. DEQ requests that PPLM discuss how "spikes", usually single-event large increases or decreases in concentration, are handled during remedy assessment. An example is found in Figure 3-13 for boron and chloride concentrations for Well 16SP.

DEQ requests that PPLM discuss sudden step-wise increases or decreases in concentration (e.g. Figure 3-11, Well 16SP, boron and chloride concentrations) are handled during remedy assessment.

Response: Groundwater remediation using pump and treat techniques is a lengthy process in most cases. Although, short term changes are noted and considered, at least in the short term, as beneficial, there is little in relative importance in the overall evaluation of the effectiveness or success of mitigation measures. Rapid short term improvements are more likely to be observed when concentrations of the impacted water are high relative to the surrounding waters. In this *case, rapid improvements are noted. However, longer term observations are more important to note since rapid improvements in quality typically give way to lower rates of improvement and/or periodic fluctuations in quality.*

Spikes in concentrations are viewed as rapid, releatively short lived, increases and decreases in concentrations of pamameters. No spikes are indicated for the referenced water quality graphs for 16SP, perhaps this is a typographical error and MDEQ was referring to well 26SP. Water from well 16SP showed an increase in boron concentrations however, that based on the scale used, appears to show a rapid and substantial increase in concentrations. Although an increase from about 0.5 mg/L to 1.5 to 2.0 mg/L is observed, the increase is not considered a spike and is likely form a dilute source containing water, possibly mine spoil recharge conditions or other potential sources that occur in the area.

Perhaps MDEQ was referring to Figure 3-13 and the "spike" that appears on the graphs for that well. If individual parameters spike, without increases in concentrations of other indicator parameters, then the data are checked, laboratories are contacted to verify the results, and resampling may be conducted. If a follow up sample shows normal levels of the parameter, the initial sample is watched and may be flagged as anomalous at a later date once additional samples have been collected to verify the erroneous result. However, in the case of well 26SP, spikes in multiple parameters occurred at once. The values were immediately rechecked and field conductivity and water levels measured to confirm the results. Based on the extreame and rapid rise in concentrations of chemical constituents which were confirmed by followup investigation, PPLM immediately began pumping water from well 26SP and began investigating the area for the cause. A liner breach was discovered in the D4 Brine pond. The quick response resulted in concentrations of chemical constituents to drop relatively rapidly.

4. **DEQ requests that PPLM justify the basis for the subdivision of the Plant Site Area into the subareas discussed in Section 3.6.1, 3.6.2, 3.6.3, 3.6.4, and 3.6.5. It is not clear if the basis for the delineation into subareas is purely geographical or whether differences in water chemistry, hydrogeology, geology, or land use were used.**

Response: The areas were identified based mostly on geographic location and in some cases land use (Brine Pond Area). Water chemistry, hydrogeology, geology, or land use were used to a lesser extent since the process water indicators are relatively consistent, hydrogeology varies within individual geographic or land use area, as does geology.

Comment:

1. DEQ is unsure if the subareas described in the subsections of Section 3.6 fully cover the extent of the Plant Site Area. Areas that may not be included in the discussion are: 1) the area near the four boiler units, with the 800-series wells and "U" wells; 2) the area north of the four units across the road near the North Pond (wells 23S, 23M, and 24S); 3) the area north of the Units 1 & 2 A/B Flyash Pond including the Units 1 & 2 Bottom Ash Clearwell and Sediment Retention Pond and wells such as SRP-1, 42S, 49S, 46A, 78a, 77D, 76A, 30S-2, and AB12-S; 4) the area furthest west of the Units 1 & 2 Flyash Pond A Side (wells located in the town of Colstrip and near East Fork Armells Creek) including wells such as 15D, 15 S, 95A, 95D, 00A, 99D, 103D, 104A, CA-18, and 101A; 5) the "P" wells located in the extreme southwest of the Plant Site Area near East Fork Armells Creek; 6) the area located west and southwest of the Cooling Tower Blowdown Ponds C including wells such as 127M, 127R, 39M, 39S, 69R, 14M, 61M, 62S, 67M, 68A, 129D, 130M, 10S, and 10M. If these areas are parts of the subareas described in the subsections, please include these areas in the effectiveness assessments in the appropriate subsections.

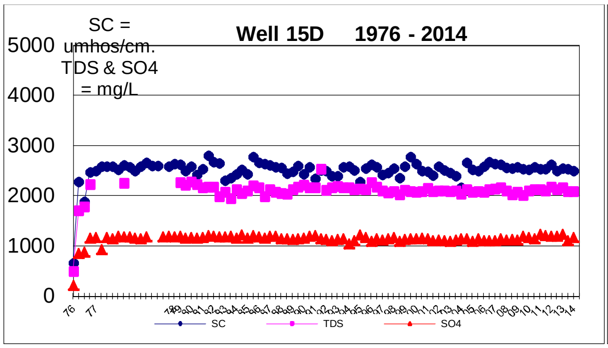
Response: Responses are as listed per each numbered item under Comment 9. Note that the referenced section is titled Effectiveness Assessment of Remedial Action.

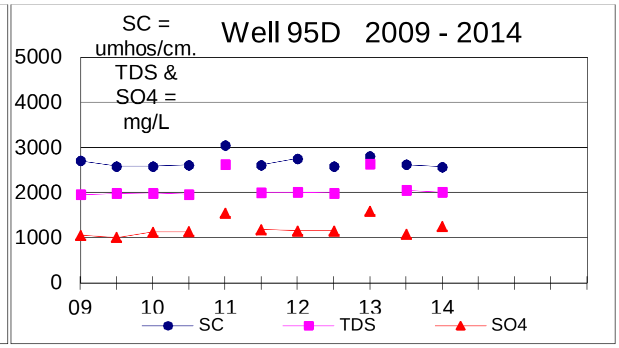
9,1). A "sub-area" was not discussed since this area, referred to as the "800-Series" well area is administrated under the Montana Department of Environmental Quality Petroleum Tank Cleanup Program. This area is impacted from turbine oil, diesel fuel, and gasoline from past spills and is not a part of the AOC. Note that sulfate and boron levels have been detected at well 811 in concentrations above the BSL for alluvium.

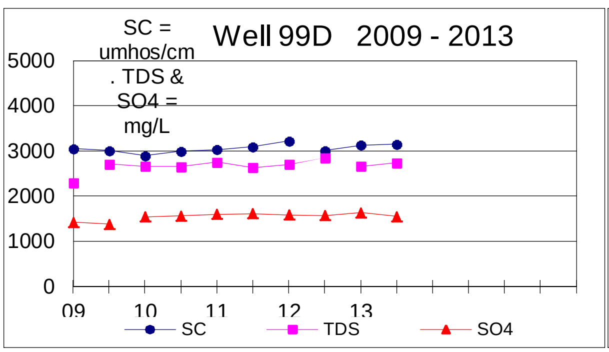
9,2). The area around the Units 3&4 North Plant Area Drain Pond (North Pond) has not shownd definative indicators of process water and text describing the water quality conditions in this area was not included. Note that concentrations of boron and chloride have exceeded BSL levels, which are under review as of Octover 2014, No remediation is ongoing in this area but groundwater monitoring continues in this area.

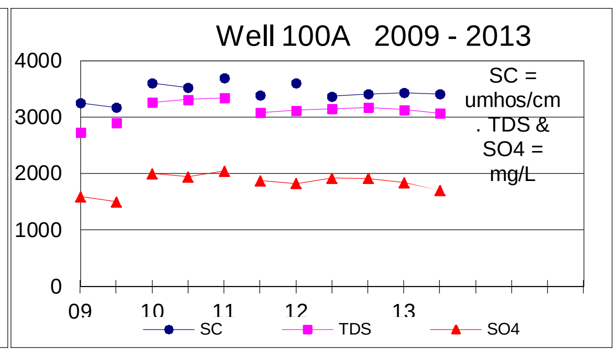
9,3). The wells listed (SRP-1, 42S, 49S, 46A, 78a, 77D, 76A, 30S-2, and AB12-S) ;are within the area identified in Section 3.5 (formerly Section 3.6) as the Northwest area. A water quality trend graph for 49S is on former Figure 3-15 (now 3-27).

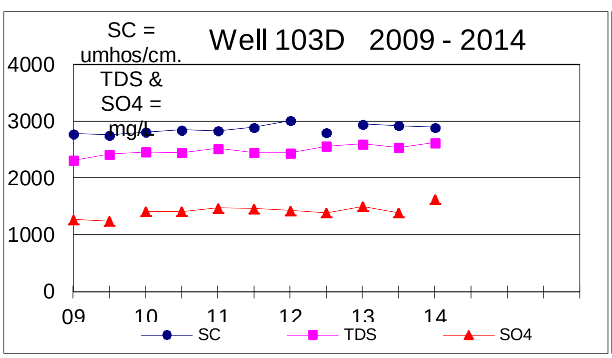
9,4). The area containing wells 15D, 15S, 95A, 95D, (1?)00A, 99D, 103D, 104A, CA-18, and 101A is described in Units 1&2 A/B Flyash Pond Area (former section 3.6.4, now Section 3.5.4). The wells listed in Figure 3-26,(formerly 3-14) include representative graphs for a variety of wells in this area. Data spreadsheets containing graphs for all the mentioned wells have been submitted to MDEQ in the form of database files with the annual reports and indepently as Excel spreadsheets following requests for the information. Further discusion has been added to the revised text for this area to further address some of the information requested. Water quality *graphs for wells 15D, 95D, 99D, 100A, 103D, 104A for SC, TDS, and sulfate are shown below to further illustrate groundwater conditions in the area.Groundwater in each of the wells shows stable trends within the ranges that would be expected by normal long term fluctuations in quality. Increases in SC, TDS, and sulfate observed at well 15D at the beginning of the data range has been attributed to the fact that the wells were initially installed using higher quality water than background as a ciruculating fluid. Concentrations of the constituents rose as the cleaner water was flushed from the well.*

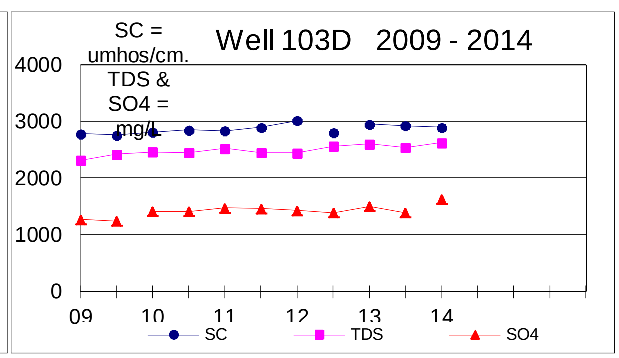












9, 5). Wells designated a P-# were installed by the Montana Bureau of Mines and Geology (MBMG) and are upgradient of the site and down gradient of mining operations. Data for these wells can be found on the MBMG website.

9,6). One phase of additional investigation has been conducted in this area since the original issuance of this report in December 2012). A second phase is planned for 2015 which will further characterize the hydrogoelgoical conditions in the area an potentially lead to additional *mitigation measures. This area is typically included in the evaluation of conditions west of the site. Water quality at capture wells 10S and 10M have shown progressive decline, partially resulting in the additional investigation. Well 98M was installed as a down gradient capture well and has shown relatively stable water quality. Well 68A, located southwest of the 10S and 10M has shown stable or very slightly improving water quality. Based on these observations, it appears that a narrow band of impacted water is flowing from the southern portion of the plant site towards wells 10S and 10M. The additional investigation is expected to further define this pathway.*

Comment:

5. In the subsections of Section 3.6, PPLM does not carefully delineate the boundaries of the areas of special interest. DEQ does concur that subdividing this very complicated area and discussing the subareas separately is useful. However, DEQ requests that the subareas be carefully defined. Please delineate the subareas on a map of the Plant Site area. Further comments by DEQ concerning this issue will be in the specific comments concerning the subsections.

Response: A very similar question was asked in comment 8 of this section of comments. Areas defined on the site are generalized, typically based on the area that an investigation originated. There is a substantial overlap of areas. Hence, it is our opinion that maps showing specific sub area boundaries would lend little advantage and would potentially be misleading. A map with general areas shown is below.

Comment:

6. **The effective assessment of the following completed plant site mitigation measures and other changes to the pond system are not discussed in Section 3.6:**
   1. **The relining of the Units 1-4 Sediment Retention Pond in 1989**
   2. **The relining of the Units 3 & 4 North Plant Area Drain Pond (date unknown)**
   3. **The lining of the Units 3 & 4 Auxiliary Scrubber Drain Pond (date unknown)**
   4. **The abandonment of the former Units 1 & 2 Bottom Ash Ponds (east of Units 1 & 2 Flyash Pond B) in 1988.**
   5. **The lining of the now-defunct Units 1 & 2 Wash Tray Pond in 1975 and the abandonment of the pond in 1980. The reuse of the same pond in 1988 as the Units 1 & 2 Bottom Ash Pond with a clay liner.**

The separation of a clearwell with a liner in 2006 from the rest of the Bottom Ash Pond.

Please discuss the impact of these changes to the pond system, using indicator parameter trends from nearby capture and monitoring wells.

DEQ is unsure which subarea (if any) contains the previously mentioned ponds. DEQ requests that PPLM refine the boundaries of the existing subareas and define new subareas if necessary.

Response: Noted, a separate section(3.7) has been added to the report to address each of the actions described above.

A map showing the "general" areas referred to around the site is included in the previous comment response.

Comment:

1. **Please incorporate the response to Comment #10 by the contractor into Section 3.6. DEQ is unsure as to in which subarea the five groundwater sumps (SRP-1 to SRP-5) are located. Please discuss, using evidence from specific wells, the impact of process pond water on nearby monitoring and capture wells. Please discuss the effectiveness of capture in the area.**

MDEQ Subcontractor Comment 10. Section 3.1. Table 3-1. March 1996 reference. The text states that each sump extends to bedrock. However, fractured bedrock is not impermeable and allows for the movement of contaminants below the alluvium-bedrock interface. Please provide data that indicates that migration of contaminants into the bedrock is addressed.

Response: Each sump is operated as a capture well. The base is completed at the bedrock interface. Groundwater capture is also occurring in wells completed in the bedrock units. In these areas, groundwater levels are lower than in the alluvium. Groundwater flow towards the bedrock wells is induced by pumping in these wells. Water potentially moving downward or laterally into the bedrock is captured by the wells completed in the deeper units.

Comment:

7. **DEQ requests that Table 6-1, 2013 Annual Report ("Units 1-4 Plant Site Area Collection Data) be added to the site report and referenced in Section 3.6. This table lists capture rates for the Plant Site area wells and underdrains.**

Response: Noted. The table has been added.

Comment:

8. **Section 3.6.1 units 3 & 4 Wash Tray Pond, 1 & 2 Cooling Water Blowdown Pond**

   Please change "Sound" to "South" in the first sentence of the first paragraph.

   DEQ requests that PPLM further describe the lateral extent of this area to the east, south, and west. To the east, DEQ requests PPLM describe whether or not the area includes the wells northeast, east, southeast, and south of the Units 3 & 4 Wash Tray Pond, including wells 29SP, 28SP, 36M, 17D, 17M, 17SP, 17 M-2, 17S, 33S, 34D, 16SP, 16M, 37SP, 37M, and 33S. To the south, DEQ requests PPLM describe whether or not the area includes the wells southeast, south, and southwest of South Cooling Tower Blowdown Pond C including wells 38M, 38SP, 6M, 6D, 6S, 39M, 39S, and 69R.To the west, DEQ requests PPLM describe whether or not the area includes the wells west of North Cooling Tower Blowdown Pond C including wells 14M, 61M, 62S, 68A, and 67M. DEQ requests PPLM describe whether or not this area extends to the northwest across East Fork Armells Creek into the Town Site and includes wells such as 104A, 103D, 99D, 100A, 60 M-P, 10S, and 10M.

Response: A map has been prepared in response to comment 12 of the section showing the general extents of different locations discussed. Note that the boundaries of these areas are not clearly defined in that there is overlap (such as well 29SP) between them. Well locations have been added to the map in response to this comment.

Comment:

Please describe groundwater flow direction in all units in this subarea.

In the second paragraph, please state definitively the overall trend in indicator parameters observed in wells completed in shallow units (alluvium, colluvium, spoil, Rosebud coal, and interburden) that occurred as a result of the abandonment of the Units 3 & 4 Wash Tray Pond in 1995.

In the fourth sentence of the third paragraph on page 3-49, please change the fourth word from "west" to "east". The corrected sentence is "Flow on the east side of this divide would be eastward and flow on the west side would be westward".

In the third paragraph, groundwater model predictions are discussed concerning capture of groundwater flow to the northwest. Please discuss the evidence for capture in capture wells such as 10M, 10S, and 68A, the evidence for process pond impacts in monitoring wells such as 67M, 62S, 14M, 61M, and

the monitoring wells down gradient of capture wells such as 105A, 60M-P, 92A, OT-12, 100A, and 99D.

Response: First sentence: Flow direction lines have been transposed from the potentiometric maps for each unit onto a new figure showing various areas of the site.

Second paragraph: Noted and text added to the report.

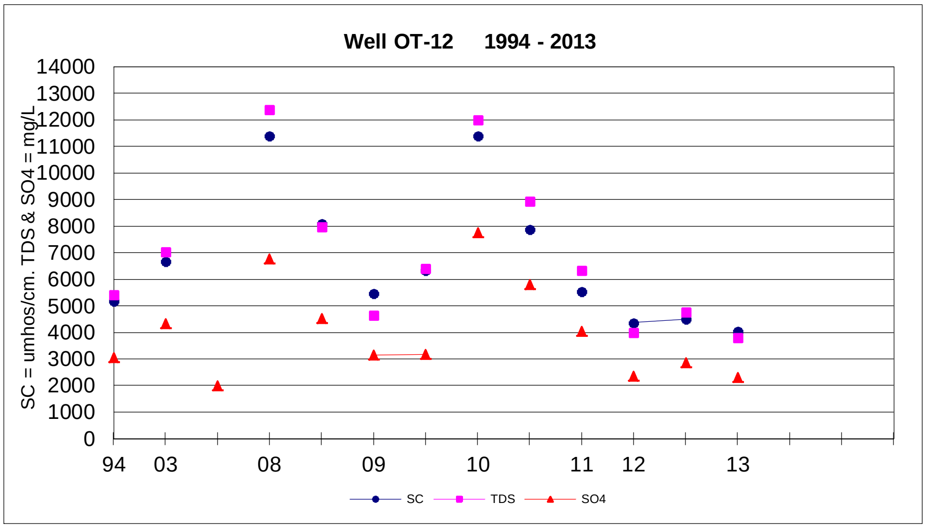
Third paragraphs: Noted and revised.

Fourth Paragraph:Groundwater capture analyses including this area are described in the Groundwater Model Report in Appendix A.

Wells 10M, 10S and 68A are capture wells located down gradient of the Units 1&2 Cooling Tower Blowdown Ponds (North and South Ponds) and the Units 3&4 Wash Tray Ponds. Groundwater from both wells 10S and 10M show evidence of process water impacts. Wells 10S and 10M show elevated levels of SC, sulfate, chloride, and low calcium to magnesium ratios. Levels of boron in 10S are elevated while those in 10M are not. Groundwater from well 68A does not show distinct process water impacts. However, the levels of SC and sulfate, coupled with a calcium to magnesium ratio of less than one indicated there are potential impacts. Levels of chloride and bromide at this well are relatively low suggesting no process water impacts. Well 68A was converted to a groundwater capture well as a conservative measure based on the inconclusive water quality and the location near the edge of the plant and position near East Fork Armells Creek. Portions of this text have been included in the report

Wells 67M, 62S, 14M, 61M, located further to the west, or paired with 68S show no evidence of process water impacts.

Well OT-12, while located downgradient of the site, is influenced by road maintenance, upstream effects on the creek, and local activities (In a parking lot).



Wells 60M-P, 92A, 99D, 100A, and 105A are located within the zones of influence of capture wells or down gradient of capture wells. Well 60M-P is located south of capture well 98M. Groundwater at 60M-P suggests some impact from process water may be occurring. SC levels were above 7000 umhos/cm, sulfate concentrations were around 4500 mg/L, boron conctrations were around 3 mg/L, Chloride concentrations were around 325 mg/L, calcium to magnesium ratios less than 1. Since well 98M began pumping in 2009, levels of SC and sulfate have dropped and calcium to magnesium ratios have increased. During this same period concentrations of boron have increased slightly and chloride concentrations have fluctuated. A slight overall groundwater quality improvement has occurred.

Wells 92A and 105A are west of the plant near groundwater capture well 106A. A slight improvement in water quality was observed at these wells shortly after the startup of well 106A. Scaling problems, however, limited the effectiveness of well 106A and water quality exhibited a minor decline. The pipeline for well 106A was replaced in 2013. Improvement in water quality is expected with continued pumping from well 106A at the higher pumping rates.

Wells 99D and 100A are a paired set located southwest of capture wells 106A, 107A, and 108A. Water at these wells does not show process water effects.

Comment:

> **Please describe how mitigation measures in this subarea (described In Section 3.5.3 and on Table 2-1) have caused documented changes in water quality as shown in indicator parameter trends in monitoring and capture wells. Specifically, please discuss how the redirection of collected groundwater, raw water, and storm runoff into Units 1 & 2 Cooling Tower North Pond (after 2004-2005) and into Units 1 & 2 Cooling Tower South Pond (after 2000) affected water quality in the neighboring wells.**

Response: The Units 1&2 Cooling Tower Blowdown Ponds were not discussed in the original report in Section 3.5.3. The strategy behind using the ponds to hold excess stormwater runoff is to maintain water near the edge of the property that contains a higher quality water than active process waters. Limited data have been available to fully evaluate changes in water quality west of the Units 1&2 Pond C North and Pond C South. Additional information has been collected from this area since the issuance of the initial report. Well 128R is completed in Rosebud Coal near the southeast courner of Units 1&2 Pond C south. Initial samples from well 128R showed 2,570 umhos/cm SC, sulfate 1,610 mg/L, boron – 0.36 mg/L, and chloride levels of 32 mg/L. Well 127D, which is paired with 128R showed similar results. Wells 129D and 130M were installed near the northwest corner of the Units 1&2 Pond C North. Concentrations of indicator parametrs in these wells showed levels that were similar to or lower than those in the adjacent pond. Although, not conclusive until additional data are collected, these data suggest the water *in Units 1 & 2 Pond C North and Pond C south may be having a positive impact on water quality in the area adjacent to the ponds.*

Comment:

DEQ requests the PPLM change "groundwater from directions" to "groundwater flow directions" in the first line on page 3-5, Section 3.6.1 per the response by PPLM to Comment #14 by the contractor.

Comment 14. Section 3.6.1. Page 3-51. First Line. The text "groundwater from directions" is not clear. Please clarify.

Response: Comment noted

Comment:

9. **Section 3.6.2 Units 3 & 4 Bottom Ash Ponds**

DEQ requests that PPLM further describe the lateral extent of this area to the east, south, west, and north. To the east, DEQ requests PPLM further describe whether or not the area includes the wells to the east including 21D, 21M, 21 SP-2, 21S, 54SP, and 53SP. To the south, DEQ requests PPLM further describe whether or not the area boundary includes the wells to the south including 53SP, 62SP, 51SP, 20M, 20SP, 20S, and 40SP. To the west, DEQ requests PPLM further describe whether or not the western area boundary includes the wells to the west including 84SP, 86SP, 85SP, 11SP, 41SP, and 90R. To the north, DEQ requests PPLM further describe whether or not the northern area boundary includes the wells to the north including 89SP, 22M, and 22SP.

Please describe groundwater flow direction in all units in this subarea.

DEQ requests that PPLM delineate the southwest boundary with the Former Brine Ponds area. Please discuss which of the following wells belong in what area: 19SP, 19D-2, 19M, 12R-2, 12M, 25SP, 4M, 4S, and 27 SP.

In the third sentence of the first paragraph, please specify which wells north of Plant Site are in place to capture water from the ponds. Please describe the trends observed in these wells.

All of the indicator parameter trends shown in Figure 3-12 are for wells installed south and southeast of the ponds. Please describe the trends observed in the monitoring wells located north and west of the ponds. If the same trends observed in the southern monitoring wells 20M and 20SP are observed in the western and northern monitoring wells, please state this.

Please describe how mitigation measures in this subarea (described In Section 3.5.3 and on Table 2-1) have caused documented changes in water quality as shown in indicator parameter trends in monitoring and capture wells.

In Section 3.6.2 only, PPLM does discuss evidence of effective remedial action involving bromide concentrations (page 3-51 third paragraph). DEQ requests that PPLM first discuss evidence from the four indicator parameters before discussing bromide. DEQ assumes that PPLM considers the bromide evidence as important. DEQ requests that PPLM compare measured concentrations in the ponds with measured concentrations in the "down gradient" wells. Please identify the ponds and the wells. Please specify the distances from the wells to the ponds. Please cite the estimated seepage rate for the ponds. DEQ requests that PPLM discuss another hypothesis that could explain the low indicator parameter (including bromide) concentrations; the heterogeneous nature of the area aquifer (spoils) causes rapid mixing of pond-impacted groundwater with other groundwaters.

In response to Comment #17 by the contractor, PPLM has submitted to DEQ a table listing water quality data for the WECO well. DEQ requests that PPLM add the table to the Plant Site Report and discuss the data in Section 3.6.2, Units 3 & 4 Bottom Ash Ponds. DEQ requests that PPLM compare and discuss water quality data for the WECO well compared with data for PPLM wells north of the Units 3 & 4 Bottom Ash Ponds that may be up gradient or cross-gradient of the WECO well. The wells include 89SP, 22M, 22SP, 21S, 21SP-2, 21D, and 21M. DEQ does not have the WECO well log. If well details exist, please incorporate the details into the subsection and send the well log to DEQ. If well details do not exist, please acknowledge this fact in the subsection.

Please discuss how the pond mitigation measures completed in this subarea have impacted water quality in surrounding wells. Specifically please comment on the effect of relining the Units 3 & 4 Bottom Ash Ponds with clay in 1991.

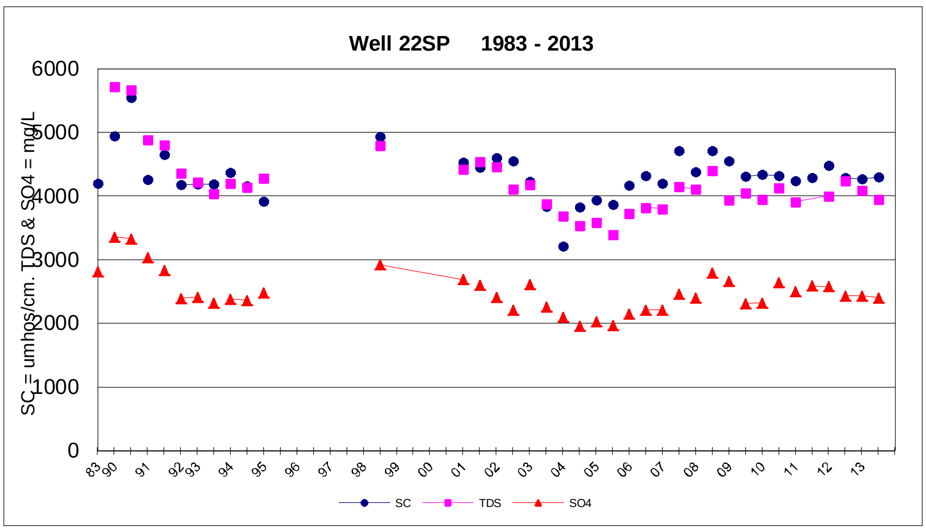
Compared to the pumping rates of other capture wells in this subarea (4.1 to 0.2 gpm), the pumping rate of the WECO well is very large (54.9 gpm). The WECO well is located north of the ponds (approximately 400-500 feet north of the nearest pond). The other capture wells are south of the ponds; the wells closest to the ponds are 60-80 feet south of the southernmost pond. The pumping of the WECO was modeled in the 2012 groundwater report; however there is no documentation in the capture zone analysis to compare the capture zone size of the WECO well with the other wells. DEQ requests that PPL comment on the relative effect of different capture zones as possibly being the reason that water quality has not

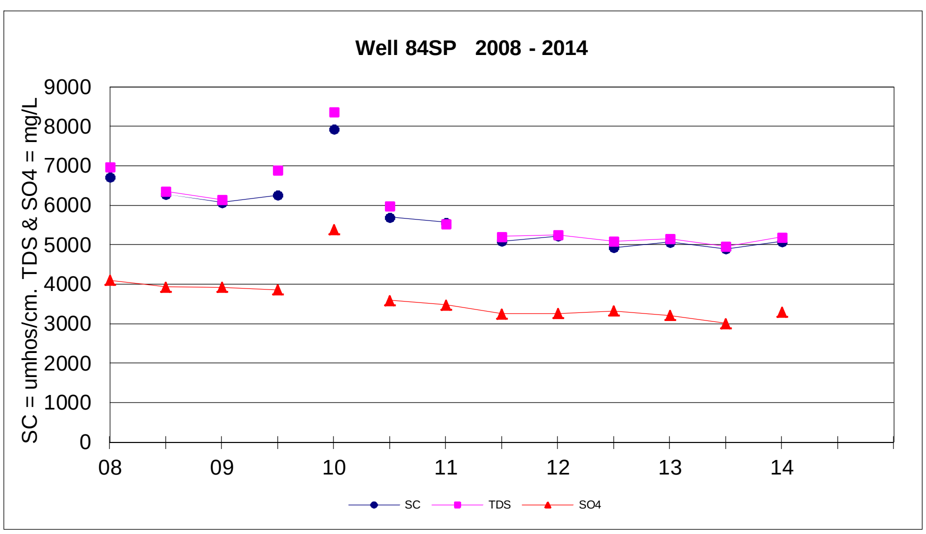
apparently improved in this subarea. Please also compare the water quality data of the WECO well to those of the other capture wells.

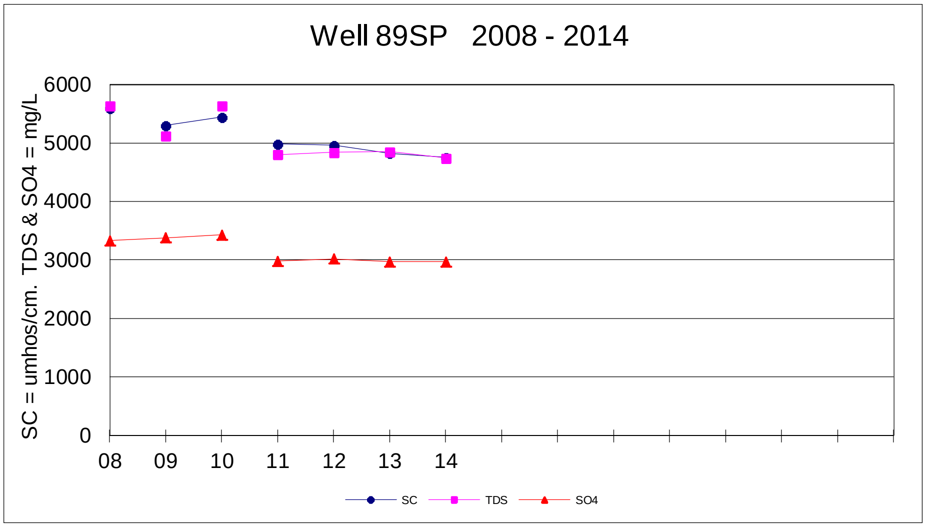
Response: Comment 15 paragraph 1, 2 & 3 - A figure has been added to the report showing the approximate area described as the Units 3&4 Bottom Ash Ponds in former Section 3.6.2 and former Section 3.6.3 Former Brine Pond Area. Well locations and groundwater flow directions are shown on the figure.

Comment 15 paragraph 4 - Wells 74A, 75A, 79A, & 81A are located to the north of the Plant Site proper.

Comment 15 paragraph 5 – Graphs showing SC, TDS, and sulfate values for the period of record are shown below. Text regarding these wells has been added to the revised report. The changes in water quality are attributed to groundwater pumping, variations in spoil water quality that is also captured, and variations in natural recharge patterns.







Comment 15 paragraph 6 - The Units 3&4 Bottom Ash Ponds were not mentioned in the original Section 3.5.3. Capture wells were mentioned in Table 2-1. These wells include 51SP, 52SP, 53SP, and 54SP. The WECO well also likely captures water from the Units 3&4 Bottom Ash Pond, spoil, and areas to the north and east of the well. At the time of this response, access to the WECO well to measure pumping water levels is not available. Pumping water level data would be helpful in groundwater model calibration in this area.

Comment 15 paragraph 7 – Text has been added to the report regarding indicator parameters. It is agreed that there are natural sources of bromide. However, with the exception of sea water, levels of bromide naturally found in the environment are typically quite low. A discussion of naturally occurring bromide has not been added to the text.

Comment 15 paragraph 8 – text regarding the WECO well has been added to the report as requested. In addition, a table containing analytical data have been added to the report as per a previous comment. A log for the WECO well has been obtained and provided to MDEQ.

Comment 15 paragraph 9 – Very little change in water quality was observed in wells 20SP or 22SP immediately following the relining of the ponds in 1991.

Comment 15 paragraph 10 – As indicated in the response to paragraph 6 of Comment 15, the WECO well is obtaining water from areas other than just the Units 3&4 Bottom Ash Ponds. Water from the WECO well has a higher conductivity than the ponds or the other collection wells. This indicates that water is drawn from areas other than the ponds. Note that this entire ara is used to handle coal. Water percolating through the coal piles and infiltrating to groundwater could potentially also be affecting groundwater quality in this area.

Comment:

10. Section 3.6.3 Former Brine Pond Area

DEQ requests that PPLM further describe the lateral extent of this area to the north, south, and east. DEQ requests that PPLM describe whether or not the area includes the northern wells 70SP, 4M, 4S, 70SP, 25SP, 12 R-2, 12M, 19D-2, 19M, 90R. DEQ requests that PPLM describe whether or not the area includes the southern wells 71SP, 26M, 25SP, and the D4 Sump. DEQ requests that PPLM describe whether or not the area includes the eastern wells 18M, 18S, 18D, 18S, 87SP, 27SP, 35M, 35SP.

Please describe groundwater flow direction in all units in this subarea.

Please describe the overall trends in parameters for monitoring wells and capture wells located north and south of the ponds such as 71SP, 26M, 26SP, 29SP, 25SP, 4M, 4S, 12R-2, 12M, 19D-2, 19M, and 19SP. If these wells are not down gradient of the area of the former brine ponds, please cite the evidence.

Please expand the assessment of parameter trends for wells located east and southeast of the ponds further down gradient of the "B" wells (B-1, B-3, B-4, B-5) including such wells as 18SP, 18M, 18S, 87SP, 28SP, 27SP, 35M, and 35SP.

Please describe the trends in indicator parameters at the D4 sump since the installation of the D4 underdrain capture system. Please interpret changes in indicator parameters and volume of leachate with respect to changes in the source.

Please expand the discussion of the mitigation assessment of the completed mitigation measures including those described in Section 3.5. This includes the closure and removal of solids from the D1, D2, and D3 Ponds in 1994, the D4 liner failure in 2006, and the closure and capping of the D4 Pond in 2005-2006. Please state if the spike in boron/chloride concentrations in well graphs on Figure 3-13 is attributable to the D4 liner failure.

Response: D4 liner failure occurred in 2005.

Response: Comment 16 paragraphs 1, & 2 - A figure has been added to the report showing the approximate area described as the Former Brine Pond Area. With the exception of well 90R, all the wells are located within the area drawn as the Former Brine Pond Area. Well 90R is directly north. Note again, that the boundaries shown on the map, and discussed in the report text, are subject to change as additional information is obtained.

Groundwater flow direction arrows, based on spring 2014 measurements, have been included to the figure that illustrates the approximate capture system area boundaries.

Response: Comment 16 paragraphs 3, 4 & 5– Text has been added to the report to address these requests.

Response: Comment 16 paragraph 6 – A description of the water quality at the D4 Underdrain Sump has not been added to the text since it adds no additional information to the report as it relates to brine pond water quality. No trends are apparent in the indicator parameters for the former D4 Underdrain Sump. Water quality at the sump reflected brine pond quality with SC levels above 60,000 umhos/cm, sufate (~60,000 to 220,000 mg/L), boron (~35 to 186 mg/L), and chloride 1,410 to 4,990 mg/L).

Response: Comment 16 paragraph 7 – Text has been added to the report. Note that the D4 Pond liner failure occurred in late 2005 rather than 2006 as indicated in this comment.

Comment:

11. Section 3.6.4 Units 1 & 2 A/B Fly Ash Pond Area

DEQ is uncertain about the eastern, western, and northern boundaries for this subarea. DEQ assumes that the wells located immediately adjacent to the A and B Ponds such as the "AB wells" and the numbered wells west of A Pond and east of the railroad track are in this area. To the south, DEQ assumes that well 88M is near the southern boundary. DEQ is unsure where the western boundary is located. DEQ requests that PPLM further describe whether or not the wells in the southernmost portion of the town site are in this area. This includes wells such as 15D, 104A, OT-13, 98A, 107A, and 109A. DEQ is unsure where the northern boundary is located. DEQ requests that PPLM further describe whether wells located in the vicinity and north of the Clear Well and the Sediment Retention Pond are in this area. This includes wells such as SRP-4, 45S, 77D, 30S-2, 46S, and AB-13S.

Please describe the groundwater flow in all units in this subarea

Please summarize and interpret the trends in indicator parameters for wells located east of B pond (such as AB-17, 72M, AB-19SM, AB-15S, AB-16S, and AB-14S), for wells located between A and B Pond (such as AB-25S, AB-27S, AB-29S, and AB-30S), for wells north of the A and B Ponds (such as AB-20S, AB-21S, AB-22S, AB-23S, AB-24S, 13M, and 13S), and south of the A and B Ponds (such as 88M).

Please expand the summarization and interpretation of the trends in monitoring wells located down gradient of the capture wells located immediately west of the A Pond. This includes monitoring wells in the town site including 15D, 15S, 101A, 93A, CA-18, 105A, 109A, 99D, 103D, 104A. Please evaluate the effectiveness of capture in this area. As usual, please discuss the trends in all the indicator parameters.

DEQ requests that PPLM precisely define what segment of the East Fork Armells Creek and which surface water measuring stations are in this subarea. For this subarea, please summarize the data from the entire 14-year set of synoptic runs concerning stream segment characteristics such as gaining and losing reaches and the water quality in the stream compared to the neighboring boreholes to the stream stations. Instead of TDS, please use the indicator parameter specific conductance in order to evaluate overall changes in water quality in the stream segment using the entire set of synoptic run data. Please also describe changes using the other indicator parameters using the entire synoptic run data for stream stations within this subarea.

In this subsection, PPLM states that water quality has improved in East Fork Armells Creek. DEQ requests that PPLM provide evidence of the improvement using the data measured during the synoptic runs. DEQ requests that PPLM clearly explain the significance of this observation to the purpose of Section 3.6, effectiveness assessment of remedial action. If PPLM is attributing the improvement of water quality to remedial actions at the Plant Site, DEQ requests that PPLM clearly state this and present supporting evidence. If PPLM is not attributing the improvement of water quality to Plant Site remedial actions, DEQ requests that PPLM clearly state this. Please acknowledge that effectiveness assessment of the improvement of water quality in East Fork Armells Creek requires an extensive multi-year analysis of the water quality data for the stream segment upstream of the Plant Site Area on the Western Energy Coal Mine property.

Please describe the trends in indicator parameters in the leachate collection systems of the Units 1 & 2 Bottom Ash Clearwell and Units 1 & 2 Flyash Pond Pond B. Please interpret changes in indicator parameters and volume of leachate with respect to changes in the source.

Please include a discussion of the documented mitigation effects of the completed remedial actions in the subarea (including the relining of the Units 1 & 2 Flyash Pond B Pond in 2004, installation of the underliner drain in the B Pond in 2004, changes in water management of the B Pond from receiving fly ash to receiving "scrubber return water" from STEP in 2004, and changes in water management of the A Pond from receiving fly ash to receiving storm water and other clear water in 2005).

With respect to Section 3.6 in general, DEQ has requested the replacement of the discussion of TDS by a discussion of specific conductance. However, PPLM may be linking TDS values with the well scaling problem discussed in Section 3.64, first

paragraph. If this is the case, please clearly link TDS to scaling. DEQ notes that this is the only subarea for which PPLM has discussed scaling. If scaling is only an issue in one subarea, DEQ requests that PPLM explicitly state this. Based on current *understanding, DEQ requests that PPLM explain why scaling is not an issue for the other subareas.*

Response: Comment 17 paragraph 1- A figure has been added to the report showing the approximate area referred to as the Units 1&2 A/B Flyash Pond Area (Figure 3-26). The western border of this area is approximately coincident with East Fork Armells Creek which is a local hydrologic divide. Wells in the southern portion of the townsite are in this area. Well 88M is near the southern border of this area. The northern extent of this area is coincident with Willow Ave.

Response: Comment 17 paragraph 2– Groundwater flow direction arrows, based on spring 2014 water level measurements, are included on Figure 3-26. Potentiometric maps for each interval are also included in figures found in Section 3. Groundwater flows perpendicular to the potentiometric lines.

Response: Comment 17 paragraph 3 – Note that wells labeled as AB-## were installed to investigate the Units 1 & 2 AB Ponds. These wells were sampled during the initial investigation but have only recently been added to the monitoring program and are scheduled for sampling every once every three years. Because of the small amount of data, use of the wells for long term trend purposes is not possible. However, text has been added to the report, when adequate data are available, which describes water quality trends at these wells, as requested. Note that a very limited data set (1-2 samples) are available for wells AB-15S, AB-21S, AB-24S, AB-30S and trend descriptions are therefore not included in the text.

Response: Comment 17 paragraph 4- Text has been added to the report.

Response: Comment 17 paragraphs 5&6 - Synoptic run sites AR-5 and AR-4 are west of the Plant Site Proper and the Units 1&2 AB pond system. AR-3 is in the area referred to in the report as the Northwest Area. AR-12 is upgradient of the site near Highway 39. An appendix containing the 2014 Spring Synoptic Run Technical memorandum and additional graphics and text is included as Appendix F. These data provide extensive information regarding water quality trends at each of the synoptic run monitoring sites located on East Fork Armells Creek. Discussions of TDS have been replaced with a discussion of SC, except for an inserted section regarding loading in East Fork Armells Creek. The reason for use of TDS in this instance is that loading can be more accurately calculated using TDS values than SC measurements.

It is acknowledged that upgradient activities (mining, highway and road maintenance, activities in the town of Colstrip, etc.) need to be considered when evaluating causes of changes in water quality and/or flow in East Fork Armells Creek.

Response: Comment 17 paragraph 7 – It is unclear what this comment is requesting.

Response: Comment 17 paragraph 8 – Text has been included in various parts of the report to address this comment.

Response: Comment 17 paragraph 9 – Scaling problems occur at in wells and discharge piping along the west side of the Plant Site and in wells and pipelines in the Brine Pond recovery system. Scaling is a combination of biological scale and chemical scale (typically calcium carbonate). Among other problems, scaling causes reduction in the inside diameter of piping and sometimes blocks flow all together, interferes with valve operation, interferes with well efficiency and potentially can result in well failure. Scaling occurs in some areas, while not in others because of the water chemistry, presence or absence of sulfer reducing bacterial, and concentrations of chemical constituents in the water. Pump operation in capture systems may also increase scaling, particularly if there is frequent pump cycling, high pump temperatures, and large amounts of drawdown. PPLM uses anti-scalant additives (biocides, chlorine) to reduce scale buildup. PPLM also conducts periodic well maintenance (physical and/or chemical) to improve performance of wells. This may involve acid treatment followed by air-jetting. In some cases, piping cannot be cleaned of scale by either physical or chemical methods. In this case, piping is replaced. Pump life may also be reduced due to overheating caused by restriction in the discharge piping. Pumps are replaced when they fail.

Comment:

12. Section 3.6.5 Northwest Area

DEQ is unsure where the northern and southern boundaries are located. Please indicate if L-1, L-2, and L-3 are in this area. Please indicate if any of the wells near the Sediment Retention Pond such as wells AR-4P-W, 45S, 44S, 77D, 31M , and 76 A are within this area.

Please describe groundwater flow in this area.

DEQ requests that PPLM discuss the parameter trends in the area wells for all indicator parameters. Please discuss trends in specific conductance rather than TDS.

DEQ requests that PPLM discuss as a group the parameter trends in the monitoring wells down gradient of the Units 1-4 (?) Sediment Retention Pond. The question mark indicates that DEQ is not completely sure of the pond identification. Please indicate if the trends in parameters for 81A and 64A are representative of all of the monitoring well trends. Please discuss any exceptions.

Please discuss the opposite trends in boron and chloride plotted in Figure 3-15 for the capture wells 45S and 49S.

DEQ requests that PPLM precisely define what segment of the East Fork Armells Creek and which surface water measuring stations are in this subarea. For this

subarea, please summarize the data from the entire 14-year set of synoptic runs concerning stream segment characteristics such as gaining and losing reaches and the water quality in the stream compared to the neighboring boreholes to the stream stations. Instead of TDS, please use the indicator parameter specific conductance in order to evaluate overall changes in water quality in the stream segment using the entire set of synoptic run data. Please also describe changes using the other indicator parameters using the entire synoptic run data.

In this subsection, PPLM states that water quality has improved in East Fork Armells Creek. DEQ requests that PPLM provide evidence of the improvement using the data measured during the synoptic runs. DEQ requests that PPLM clearly explain the significance of this observation to the purpose of Section 3.6, effectiveness assessment of remedial action. If PPLM is attributing the improvement of water quality to remedial actions at the Plant Site, DEQ requests that PPLM clearly state this and present supporting evidence. If PPLM is not attributing the improvement of water quality to Plant Site remedial actions, DEQ requests that PPLM clearly state this. Please acknowledge that effectiveness assessment of the improvement of water quality in East Fork Armells Creek requires an extensive multi-year analysis of the water quality data for the stream segment upstream of the Plant Site Area on the Western Energy Coal Mine property.

Please describe how mitigation measures in this subarea (described In Section 3.5.3 and on Table 2-1) have caused documented changes in water quality as shown in indicator parameter trends in monitoring and capture wells.

Response: Comment 18 paragraph 1&2- A figure has been added to the report showing the approximate area referred to as the Northwest Area (Figure 3-27). Groundwater flow direction lines are included on the figure and are based on spring 2014 water level measurements. Note that as mentioned previously, boundaries of the areas described are not "hard" boundaries. These areas are discussed more in terms of groundwater capture that is occurring in the area or a general geographical area on the plant site. As such, wells 44S and 45S are near the boundary of the Northwest and Units 1&2 A/B Flysash Pond areas. Wells 31M and 76A would fall into the Units 1&2 A/B Flysash Pond area. Wells L-1, L-2 and L-3 are not currently shown in the Northwest Area. These three wells are shown on the map but are actually City of Colstrip wells. Periodic samples are collected from these wells, however, and reviewed. Piezometer AR-4P-W is located on the western stream bank near the crossing of East Fork Armells Creek and Willow Ave. near the edge of the Northwest and Units 1&2 A/B Flysash Pond areas. Data for all the wells mentioned are examined when evaluating hydrologic conditions at the site.

Response: Comment 18 paragraph – 3 – Noted and text revised

Response: Comment 18 paragraph – 4 – The pond in question is the Units 1-4 Sediment Retention Pond. Wells 45S, 64A, and 81A are all downgradient of the Units 1-4 Sediment Retention Pond. Water quality shown for these wells is typical for wells in this area although the magnitude of constituent concentrations vary. Also note that chloride has shown an increase in some of the wells in this area due to chlorine sourced at the chlorination plant.

Response: Comment 18 paragraph – 5 - Noted and text revised

Response: Comment 18 paragraph – 6&7 – please refer to comment response for Comment 17 paragraphs – 5&6. Synoptic run site AR-4 is located at the upstream edge of the area referred to as the Northwest Area and AR-3 is located near the downstream edge of this area.

Response: Comment 18 paragraph – 8 – Text has been added to the report.

Comment:

13. Section 3.7 On-going Investigations/Activities

In the first sentence of the fourth paragraph, please add "2012" after the phrase "late November."

DEQ requests that PPLM update Section 3.7. Please add descriptions on new ongoing investigations and activities as of September 2014. Concerning work that has been finished since the December 2012 data of issue of the Plant Site Report, DEQ requests that a description of the work be added to Section 3.5.

Response: First comment noted.

Text referring to additional investigations conducted since the initial issuance of the Plant Site History Report in December 2012 has been added to other sections of the report based on previous MDEQ comments and as part of the request to update the report. The section regarding on-going investigational activities has been updated.

Comment:

D. Section 4.0 Groundwater Results and Interpretation

DEQ requests that PPLM add a sentence to the first paragraph stating that development of a groundwater model for the Plant Site Area is required for the AOC.

DEQ requests that PPLM list the main reasons for the updated groundwater model. Please specifically list capture system analysis as a reason.

Please specifically reference the groundwater model report (Appendix A) for more details.

(Please note that most of DEQ's comments concerning the model will be contained in the response to the groundwater model report.)

Response: Sentences 1 and 2 - noted and added to the report

Response: Sentence 3 - The groundwater model report is contained in Appendix B.

Response: Sentence 4. Note that model comment responses will be answered in response to specific model report comments.

Comment:

E. Section 5.0 Identification of Data Gaps

1. First bullet:

DEQ has requested in the response to the groundwater model report more documentation concerning the particle capture analysis. Using this new documentation, please justify the data gaps listed in this bullet item and the second bullet.

DEQ requests clarification concerning the name of the third area, North Plant Area Drain Pond. Please make all names of ponds consistent with the names on Figure 2-1 and Table 2-1.

Please specify the location of data sampling and the types of data needed to evaluate the particle capture analysis of the groundwater model for accuracy. DEQ presumes that PPLM would propose drilling screened wells in these three areas with subsequent sampling.

Concerning the first two areas (south/east 3&4 Wash Tray Pond and southeast Units 3 & 4 Bottom Ash Pond), DEQ requests that PPLM consider and discuss the model limits on accuracy of location of particle pathlines for the model cell size, the model time step, the expected groundwater velocities in the two areas, and the documented variable-scale heterogeneities of the spoil material.

Response: Section 5.0 First Bullet paragraph 1- Text in paragraphs 1 and 2 has been revised based on results of the revised Plant Site groundwater model.

Response: Section 5.0 First Bullet paragraph 2 – Noted

Response: Section 5.0 First Bullet paragraph 3 – An extensive monitoring network is present at the site. As necessary, additional data are obtained. In some cases this involves additional monitoring wells, and/or additional sampling. Additional investigation has been conducted in *the Plant Site since the issuance of this report in December 2012. Summaries of those investigations are included in various portions of the report. Data obtained from these investigations has been integrated into the upgraded groundwater model. If additional data gaps are identified through modeling, observation, evaluation of analytical data or water level information, then additional investigations are conducted to obtain the necessary data.*

Response: Section 5.0 First Bullet paragraph 4 – Numerous comments specific to the groundwater model were in regards to the information requested. The section this comment refers to is data gaps. The information requested in the comment is provided in the revised model report in Appendix A.

Comment:

2. **Second Bullet:**

DEQ has requested in the response to the groundwater model report more documentation concerning the particle capture analysis. Using this new documentation, please justify the data gaps listed in this bullet item.

DEQ suggests that the first bulleted item and the second bulleted item be combined together. Both bulleted items concern particle capture analysis and the areas mentioned in the two items appear to overlap.

DEQ requests clarification why groundwater capture in shallow units east of the Units 3 & 4 Bottom Ash Ponds (first area) is described separately from groundwater capture in shallow units east and southeast of the Units 3 & 4 Bottom Ash ponds (second area).

DEQ requests clarification concerning the name of the third area, North Plant Drain Pond. Please make sure all names of ponds are consistent with the names on Figure 2-1 and Table 2-1.

DEQ requests clarification concerning the areas mentioned west of the North Plant Drain Pond in the first and second bulleted items. Please explain if the third data gap area in the first bullet is the same area or a different area from the third data gap area in the second bullet. If the two areas are the same, please explain why the area is mentioned in both the first and second bulleted items.

Please specify the location and the types of data needed to evaluate the particle capture analysis of the groundwater model for accuracy.

Please add the word "indicate" after the phrase "Model simulations" in the first sentence per PPLM's response to Comment #16 by the contractor.

Response: Section 5.0 Second Bullet paragraph 1 – This request was made, and a response provided under bullet 1 above.

Response: Section 5.0 Second Bullet paragraph 2 – Noted, change has been made to the text

Response: Section 5.0 Second Bullet paragraph 3 – There is a typographical error in the second bullet. This has been changed so that the Units 3&4 Wash Tray Pond is referenced first.

Response: Section 5.0 Second Bullet paragraph 4 – Noted. The pond referred to is the Units 3&4 North Plant Area Drain Pond, generally referred by site personnel as the North Pond.

Response: Section 5.0 Second Bullet paragraph 5 – Noted, and the first and second bullets will be combined as suggested in paragraph 2 of this comment section.

Response: Section 5.0 Second Bullet paragraph 6 – MDEQ has submitted numerous comments regarding model calibration and capture analysis. These comments have been responded to in those responses. Note, however, that the site has an extensive network of monitoring wells which are routinely monitored for levels and quality. Calibration of the groundwater model to these data points provides a certain degree of assurance of model accuracy. Furthermore, transient simulations using data obtained through capture system startup and normal pumping scenarios and pumping tests provide a further level of confirmation. Groundwater models provide simulations of conditions expected for a specific area, in this case the Plant Site. Confirmation of the accuracy of the model is accomplished through the calibration process mentioned above.

Response: Section 5.0 Second Bullet paragraph 6 – Noted. This paragraph has been combined with the first paragraph making this edit unnecessary.

((MDEQ Contractor Comment 16. Section 5.0. Bullet 2. The first sentence is not clear and appears to be a fragment. Please clarify.)

Response: This is a typographical error. The sentence should read: "Model simulations indicate incomplete groundwater capture".

Comment:

3. **Third bullet:**

DEQ requests that PPLM specify if the desired water level measurements at the WECO well are to be during pumping and capture or when the pump is switched off. In the comments concerning Section 3.6.2, DEQ requests that a small table of

water quality data for the WECO well be added to the site report. DEQ requests that PPLM specify if additional water quality sampling from the WECO well is also desirable if the well is capturing water from ponds.

(MDEQ Contractor Comment 17. Section 5.0. Bullet 3. Please provide water quality data for this capture well, if available.)

Response: Field conductivities are routinely collected from the well. SC of the discharge water is typically 4,900 to 5,000 µmhos. Laboratory data from the WECO well is available for the 2008-2012 is attached as Table Comment 17 Response WECO Well Water Quality Data.

Response: Section 5.0 Third Bullet

As requested by the MDEQ contractor in the original comments and in response to previous comments in this document, a table has been added to the report illustrating the WECO water well quality record. PPLM believes that the current monitoring schedule is sufficient.

To date, water level measurements have not been obtained from the WECO well. Additional contact will be made in attempts to agree on a method that water level measurments will be made. Two main options exist for obtaining water levels. The first would involve installing a tube in the well that would allow a water level meter to periodically be inserted in the well to measure the water level. Water levels measured in this fashion may be either static, non-pumping but recoverying water levels, pumping with dropping water levels, or pumping with consistent water levels near the pump intake. Shutting down the pumps to obtain static measurments would possibly result in flooding of the coal crusher. The second method would also involve installing a tube in the well that would allow installation of a pressure transducer with a data logger. This would allow measurement of water levels during all phases of operation. Note that the well casing is currently very full so installation of tubing my be difficult or impossible. Sonic instruments exist that could possibly be used for measurments. However, these instruments have difficulty obtaining accurate measurments if pumps, pipe joints, wires, etc. are in the well that can result in reflected sonic signals in addition to water levels.

Comment:

4. **Fourth bullet:**

   DEQ requests further clarification concerning how PPLM proposes to more accurately measure flows given the scaling issues for inline flow meters and the issue of back pressure in the lines limiting flow. Non-contact flow meters for the measurement of slurry flows are commercially available (e.g. meters using ultrasonic Doppler measurements). Please discuss if non-contact flow meters have been evaluated at the Plant Site.

   Recently, PPLM has started to apply an empirical correction to flow measurements at the well head. Is this what PPLM is proposing as a solution?

Response: Section 5.0 Fourth Bullet – Note that groundwater is being pumped from the capture wells not slurry.

Methods that are available to improve the accuracy of flow from capture wells include:

- *installation of flow meters in areas that don't have substantial scaling issues. This approach would limit accuracy to a relatively limited area. Data obtained fromt eh flow meter measurents could nto be used to estimate other flow measurments.,*
- *installation of pressure gages at wellheads that do have scaling issues*
    - *this will allow a flow to be estimated based on the pump curve and pressure measurement –*
    - *note that the accuracy of this method will decrease with pump wear and is highly dependent on the state (pumping or not pumping) of other pumps on the pipeline.*
- *Non-contact flow meters have been used in the past with variable success.*
    - *These instruments measure the velocity of a fluid (groundwater in this case) which is multiplied by the <u>area of the pipeline</u> to obtain a flow rate. Scaling of pipelines reduces the inside diameter of the pipe. Measurements calculated assuming the original pipe thickness are inaccurate in scaled pipe. Furthermore, the ability of the non-contact instrument is inhibited by scale buildup.*
    - *Reproducability of measurements using these instruments was poor and the method was not employed.*
    - *Newer non-contact flow meters may be available that would provide better reproducability of flow velocities in pipes that don't exhibit scaling issues.*
- *Manual flow measurements are sometimes conducted. This involves turning off an entire system and starting one well at a time and then measuring a flow from the discharge end of the pipeline. This provides accurate measurement for one well with only that well operating. The degree of accuracy diminishes as additional pumps are started.*

The above discussion has been added to the text. Empirical adjustment of capture volumes will continue to be used until more dependable methods become available. Note that specific adjustments of individual systems may be possible to increase the accuracy of the empirical approach.

Comment:

5. **Fifth bullet:**

DEQ requests that justification be added. If investigation associated with an interim work plan is underway or has been completed, DEQ request that PPL synopsize the important findings under this bulleted item.

Response: This information is provided in Table 3-2 (original Table 3-1) and Section 3.8.

Comment:

6. **Sixth bullet (North Sediment Retention Pond):**

   DEQ requests that PPLM specify if the "North Plant Area Drain Pond" of the model report is the same as the "North Sediment Retention Pond Area" of the site report. If the same area is represented by the two names in the two reports, the area is briefly discussed in Section 5.0 (Capture Analysis) of the groundwater model report. Please make sure that the pond name is consistent with the pond names in Figure 2-1 and Table 2-1.

   DEQ requests clarification if the "North Sediment Retention Pond area" discussed in this bulleted item is the same as the "area west of the North Plant Area Drain Pond" discussed in the first and second bulleted items. If it is, DEQ suggests the discussion in the three bulleted items could be condensed into a single bulleted item concerning spatial data gaps suggested from groundwater model capture analysis. If not, DEQ requests that the area discussed in this bulleted item be clearly described and distinguished from the areas discussed in the first and second bulleted items.

   DEQ requests that justification be added. DEQ requests that PPLM describe the potential role of the wells 23S, 23M, and 24S in the proposed area investigations.

Response: Section 5.0 Sixth Bullet – First paragraph - The North Plant Area Drain Pond (Units 3&4 North Plant Area Drain Pond) and the North Sediment Retention Pond (Units 1-4 North Plant Sediment Pond) are different ponds. Revisions have been made to the figures and tables of this report.

Response: Section 5.0 Sixth Bullet – Second paragraph - The two ponds are different. The pond referred to under the sixth bullet is the Units 1-4 North Plant Sediment Pond. The text has been revised for consistency.

Response: Section 5.0 Sixth Bullet – Third paragraph - Noted and revised.

Comment:

7. **Seventh bullet:**

   DEQ requests that PPLM add justification. DEQ suggests that PPLM describe how groundwater flows to the northwest towards East Fork Armells Creek in this area and the low number of wells in the extreme southwest portion of the Plant Site Area make characterization of the groundwater difficult.

DEQ requests that PPLM add that work in the area south, east, and west of Well 6M, south of the Units 1 & 2 Cooling Blowdown Ponds (North and South Cooling Blowdown Pond C) and the Wash Tray Pond (Units 3 & 4 Wash Tray Pond) has been initiated as documented In the Interim Response Work Plan "Monitoring Well Installation and Conversion Near Well 6M" submitted in November 2013. Please synopsize in this bulleted item the justification as outlined in this IRW plan.

Response: The text has been revised. Note that descriptions of the work conducted in the Units 3&4 Wash Tray Pond and Units 1&2 North and South Cooling Tower Blowdown Ponds is described in Section 3.8 so additional discussion was not included under this bullet.

Comment:

8. **Eighth bullet:**

DEQ requests that PPLM fully explain the issue. Please review the significance of the saturated hydraulic conductivity value to the calculation of the pond seepage estimates in Section 2.3, referencing the Bouwers Equation on page 2-33. Please specify that the measured hydraulic conductivity values used in the calculations were from laboratory measurements, not in-situ measurements after liner installation.

DEQ requests that PPLM discuss the important effects that can potentially affect and alter the conductivity of the liners from the laboratory values:

a. **Incorrect placement or compaction of clay layers during construction.**
b. **Development of desiccation cracks if liners undergo drying during prolonged exposure to air.**
c. **Freeze-thaw degradation if liners are not covered by a protective layer or water.**
d. **Long-term exposure to high concentrations of cations such as magnesium, calcium, sodium, and potassium in highly saline waters.**

Please clarify that the phase "highly saline waters" characterizes the water in the ponds, the water leaking from the ponds into the ground, and the native groundwater underneath the ponds.

Please add the word "the" to the first sentence before the phase "clay lined ponds".

These requests from DEQ address the issues raised in Comment #18 by the contractor.

Response: Section 5.0 Eighth Bullet – First paragraph - The text does state that values used for clay liner permeability calculations were compared to laboratory derived values. Adjustments were made, as described in the report, to better simulate actual conditions. Additional explanation has been added to the referenced bullet.

Response: Section 5.0 Eighth Bullet – Second paragraph - The text of the report has been revised.

Response: Section 5.0 Eighth Bullet – Third paragraph - Highly saline water contains water with dissolved salts of 10,000 parts per million(ppm) to 35,000 ppm (http://water.usgs.gov/edu/salineuses.htm. Not all of the ponds contain highly saline water. Currently only the Units 1&2 B Pond contains highly saline water.

Water "leaking" from the Units 1&2 B Pond would be highly saline.

"Native" groundwater below the ponds would typically be moderately saline, containing total dissolved solids of 3,000 to 10,000 mg/L (ppm).

Response: Section 5.0 Eighth Bullet – Fourth paragraph - Noted

Response: Section 5.0 Eighth Bullet – Fifth paragraph - Noted below

Referenced MDEQ Subcontractor Comment: "Comment 18. Section 5.0. Page 5-2. Bullet 4. Given the statement that highly saline water can alter the clay liners, please provide DEQ with an indication of how reliable PPLM believes the seepage calculations are and what steps will be taking to verify hydraulic conductivity values."

Response: PPL believes the calculated seepage rates are reasonable, if not conservative.

Comment:

9. **DEQ requests that PPLM add a new bulleted item to address the data gap concerning the lack of information below the surface of the ponds, near and at the liners, and below the liners. This would correspond to the twentieth bulleted item in section 6.0.**

Response: A new bullet has been added to address sampling at depth in the ponds. It is suggested that duplicate samples be collected from individual ponds, one from the surface as is usually conducted, and one at depth – near the bottom of the pond. Sample results will compared and the value of the sampling will be evaluated. Additional samples will be collected if the data collected from the limited initial sampling shows large variations in quality between *samples collected just below the surface of the ponds and at depth. A limited amount of ponds will be sampled.*

Samples from directly below the pond liners are not recommended. Attempts to collect such samples could lead to liner damage and leakage from the ponds. Damage could occur from direct penetration or if problems arise when attempting to collect the samples that could result in piping through silt rich materials below the ponds.

Comment:

F. Section 6.0 Recommendations for Additional Site Characterization

1. **Second bullet:**

   DEQ requests that PPLM add that evaluation of the seasonal variation of the potentiometric surfaces will be done. DEQ also requests that information from the potentiometric surface will be used where available to provide checks on the capture zones and cones of depression for capture wells calculated using computer programs.

Response: This activity is currently conducted. However text has been added to report to specify evaluation of seasonal variations.

Comment:

2. **Fifth bullet:**
   DEQ requests that PPLM define what is "process water management".

Response: The following text was added to this bullet in the text. "Process water management, as referred to in this bullet, means procedures that are used to route water (this would include opening and closing valves so water goes to the correct locations and/or is stopped being routed to an area after sufficient water has been transferred. transferring water from ponds, reuse alternatives, and other methods to continue to reduce the amount of process waters on site."

Comment:

3. **Sixth bullet:**

   DEQ requests that PPLM specify what refinements are planned for the groundwater model. The groundwater model report does not specify this.

Response: The following text was added to this bullet in the text. "Model refinements would include periodically incorporating hydrogeological that has become available since the previous model was updated. Incorporate new wells, water levels, and recalibrated following these refinements. Re-evaluate groundwater simulated flow patterns and capture effectiveness."

Comment:

4. **Seventh bullet:**

DEQ requests what refinements in the parameter list for groundwater sampling are planned by PPLM.

Response: At this time, no changes to the monitoring program are planned. However, additional analytical parameters may be added from time to time to gain additional information specific to an area or an investigation. This could include collection of isotope samples, expansion of parameters (such as during synoptic runs and periodic pond sampling), or collection of a set of duplicate pond samples that would include a depth sample and a sample from the just under the upper surface of the pond.

Comment:

5. **Eighth bullet:**

    DEQ requests that PPLM specify what types of refinements are planned to the parameter list for the annual synoptic runs.

Response: Multiple sampling events have including sampling for an expanded list of parameters from the creek, streambed sediment, and groundwater immediately adjacent to the creek. A reduced set of parameters similar to that currently used by PPLM is sufficient to identify variations in water quality that may be associated with the ponds. Text indicating that the overall scope of the synoptic run should be reduced, including a reduction in the number of parameters analyzed and the type of samples collected by eliminating annual sediment and groundwater sampling, has been added.

Comment:

6. **Ninth bullet:**

    DEQ requests that PPLM provide more details of the proposed investigations. PPLM is requested to add details and justification from the submitted work plan for an Interim Response Action, "Groundwater Investigation in the OT-7 Area".

Response: Additional investigation has been conducted in the vicinity of well OT-7. A description of the additional work was included in Sections 3.5.5 and 3.8, and has been added to Section 6.0 as well. A summary of the work is as follows:

Work conducted during this investigation as an Interim Response Action (IRA) in accordance with the AOC focused on the riparian range/grazing land of the East Fork Armells Creek floodplain near residential property and slightly downhill from the BNSF Railway right-of-way. Work was conducted in accordance with the IRA work plan Interim Response Action Groundwater Investigation in the OT-7 Area Colstrip Steam Electric Station, PPL Montana, LLC (Hydrometrics, 2013).

Work conducted during this IRA included:

- *Installation of five monitoring wells;*
- *Groundwater quality sampling;*
- *Pumping and/or slug testing; and*
- *Data analysis and reporting.*

Conclusions of the investigation were:

- *Hydrogeological conditions vary greatly from the shallow alluvium to the deep alluvium. The upper alluvium consists of fine grained silts and clay and the deep alluvium consists of sub-angular to sub-rounded gravels and sands.*

- *The upper and deep alluviums are hydraulically connected. This is indicated from the similar groundwater elevations and response to pump tests in the shallow alluvium during the deep alluvium pump test.*

- *The groundwater in the upper alluvium at OT-7 and 134A has higher concentrations of chloride than the groundwater found in the deep alluvium. Higher chloride concentrations seem to be isolated near these wells and in the shallow unit in the vicinity of these wells. Higher concentrations in the shallow alluvium are likely the effect of runoff from chemical treatment of the adjacent roadway and possible concentrations of existing salts through evapotranspiration.*

- *Groundwater quality in the deep alluvium shows some indicators of process water; while groundwater sampled from the shallow alluvium appears to be influenced by more localized sources.*

- *Very little groundwater likely flows between the shallow and deeper alluvial units. This conclusion is based on the fact that the deeper unit is significantly more permeable (>2 orders of magnitude) and water elevations between shallow and deep units are similar resulting in negligible vertical gradients.*

Comment:

7. **Tenth bullet**

   Please define what "water balance" means. Please define what "refinement of water balance" means in the context of better site characterization. Does this term include conducting operations and procedures with the goal of minimizing the amount of water in the ponds? DEQ requests that PPLM specify what sorts of measurements would be desirable.

Response: The text in quotations below has been added to this bullet in the report to address this comment.

"Continue refinement of water balance. The purpose of refining the water balance is to reduce the amount of water held at the facility. Because of the large volume of water used at the site, accurately measuring water at various locations, inputs of groundwater from capture systems, and evaporation effects, either forced or natural are difficult to quantify with a high degree of precision. However, general observations can be made. A water balance is a method of quantifying or describing the amount of water flowing into or out of a system. Inputs to a water balance may include precipitation, water pumped into a facility from outside sources, groundwater flow in, surface water flow. Out puts include infiltration to groundwater, outflow of groundwater, evapotranspiration, surface water flow out, etc."

MDEQ Subcontractor Comment 21. Section 6.0. Page 6-2. Bullet 2. Given the complex and dynamic nature of this site, it appears appropriate that the water balance be continual refined and provided to DEQ for review on a periodic basis.

Efforts are continuously being taken to reduce water inventories in the ponds. These data are available in spreadsheets maintained by PPL and can be provided on a periodic basis. The information provided gives an indication of the overall gain or losses from water managed in the process ponds.

However, a detailed water balance throughout all plant operations has not been conducted for numerous reasons, including difficulty in maintaining flow gages due to scaling, variations in evaporation rates, pipes without gages, variable precipitation, and other factors necessary for accurate water balance. As discussed above, the spreadsheets that are maintained likely provide the best basis for evaluating water losses and gains for the facility.

Comment:

8. **Eleventh bullet**

Please provide justification. It is unclear if this bulleted item concerning well 40SP is related to the finding in the 2012 groundwater model report that capture may not be effective southeast of the Units 3 & 4 Bottom Ash Ponds. DEQ requests clarification.

Response: The bullet has been revised to read as follows:

One of the recommendations contained in the original submittal of this Plant Site Report in December 2012 was "further evaluate the Well 40SP area". Since that submittal, a single well, 138SP, has been installed, tested and sampled in the area between the Units 3&4 Bottom Ash Ponds and well 40SP. Data from well 138SP will be helpful in further evaluating groundwater quality and flow in this area. Furthermore, data from an investigation into this area will provide *additional data for groundwater model calibration. A brief discussion of the well installation is included in Section 3.5.2 of this report.*

Comment:

9. Twelfth bullet

DEQ requests that PPLM reference for justification the discussion in the first bullet in Section 3.5.4 concerning solids in the Units 3 & 4 Wash Tray Pond. Please specify which of the proposed activities listed in Section 3.5.4 have been done and which remain to be done.

Response: This bullet has been revised to read as follows:

Further evaluate process solids from the Units 3&4 Wash Tray Pond (see section 3.5.1) - PPLM has plans to conduct this activity in the future. Additional investigation was conducted in this area in 2014 and is summarized in Table 3-2 (see Interim Report - Monitoring Well Installation And Potential Capture Well Conversion Near Well 6M, PPL Montana's Colstrip Steam Electric Station – Plant Site, (Hydrometrics, May 2014) and Section 3.8.

Comment:

10. Thirteenth bullet

DEQ request that PPLM reference for justification of this bulleted item the discussion in the third bullet in Section 3.5.4 concerning evaluation of fly ash in the Units 1&2 A Pond.

Response: Comment noted and text has been added to the report.

Comment:

11. Fifteenth bullet

DEQ requests that PPLM expand the discussion of scaling on page 3-44 in Section 3.5.2 (first paragraph, fourth sentence) to include why scaling is occurring, where in the typical well capture system it is occurring, what are the implications for capture efficiency, and what if any is the impact of scaling on the values of the water quality parameters measured. DEQ requests that in the fifteenth bulleted item in Section 5.0, PPLM discuss what strategies might be employed to prevent or minimize scaling. DEQ consers the issue of scaling an important operational consideration that needs to be fully explained. In the first sentence of the fifteenth bulleted item, PPLM seems to be stating that only certain wells in the Plant Site Area are affected by scaling. DEQ requests that PPLM state this in

Section 3.5.2. , and discuss the why scaling occurs in certain subareas in the Plant Site Area (e.g. Trailer Park, West of A Pond, Brine Pond).

Please explicitly state that Well 106A is located west of Units 1 & 2 Pond A and is a well susceptible to scaling. Please specify that well 106A is an important capture well that captures contamination moving west from the Units 1 & 2 Pond A towards the Town of Colstrip and East Fork Armells Creek. Please explain that Well 105 A (currently a monitoring well) is located near Well 106A at about the same distance from the Units 1 & 2 Pond A. In the third sentence, please change "is" to "if" before the phrase "well 106A" (Comment #22 by the contractor).

Response to paragraph 1: A reference to Section 2.1.3 has been added to the referenced paragraph.

Section 2.1.3 contains additional information in regards to scaling. For these specific wells, anti-scalant and a biocide is added to the wells at the pump intake to reduce scaling at the pump intake and downstream pipelines. Scaling problems are a caused by a combination of water quality and pressure changes.

Response to paragraph 2: Noted and revisions have been made to the bulleted item.

Comment:

12. Sixteenth bullet

DEQ requests that the same type of corrections be added as in the first and second bulleted items of section 5.0 based on the requested documentation of particle capture analysis in the groundwater model report. DEQ will review this recommendation once the corrections are made to the satisfaction of DEQ.

Response: It is unclear exactly which section is being referred to. The original report had 8 bullets in Section 5. We are assuming the above comment referring to the 16th bullet in Section 6. This 16th bullet in Section 6 refers to model results. The following has been added to Section 6.

Additional wells east of the Wash Tray Pond, southeast of the Units 3 & 4 Bottom Ash Ponds and West of the Units 1-4 North Plant Sediment Retention Pond were recommended in the original submittal. Since that time, additional wells have been installed in the Wash Tray Pond area and southeast of the Units 3 & 4 Bottom Ash Ponds should be considered. Additional wells are proposed for the Units 3&4 Wash Tray Pond and Units 1&2 North and South Pond area. Additional monitoring is suggested for the new well installed by the Units 3&4 Bottom Ash Pond. Based on model recommendations, additional wells and sampling should evaluated for this area. In addition, wells west of the North Plant

Sediment Retention Pond are recommended. The purpose of these wells would be to evaluate groundwater quality in these areas to determine if further groundwater capture should be considered.

Comment:

13. Seventeenth bullet

DEQ requests that PPLM incorporate the language of the response to Comment #23 by the contractor concerning changing access to the WECO well for water level measurements.

Response: Noted and the below text has been incorporated into the report.

Comment 23. Section 6.0. Page 6-2. Bullet 9. Please provide further information on what PPLM means by possibly altering access to the well.

Response: As constructed, the well cannot be accessed without removing the sanitary seal and possibly damaging the well head and equipment near the well head. The intent of well head alterations would be to allow each access for water level measurements while eliminating the possibility of causing operational problems that could occur if water gaging equipment is placed in the well. These alterations may require changing the type of well head to one with multiple access ports through the top.

WECO will be contacted again about possibly gaining better access to the well.

Comment

14. Eighteenth bullet

DEQ requests that PPLM reference how scaling affects in-line flow meters as discussed in Section 3.5.2. Please list the alternative methods of flow measurement that PPLM is considering testing. Please incorporate language concerning future plans concerning flow meters from the response by PPLM to Comment #23 by the contractor. Please include how flow rate measurements for wells without scaling problems and for wells with scaling problems will be separately handled. DEQ considers the issue of the lack of flow meters an important operational problem. The requests by DEQ are the response to Comment #24 by the contractor.

Response: The following text has been added to the report in Section 6 regarding the WECO Well and access.

> *"As constructed, the well cannot be accessed without removing the sanitary seal and possibly damaging the well head and equipment near the well head. The intent of well head alterations would be to allow easy and safe access for water level measurements while eliminating the possibility of causing operational problems that could occur if water gaging equipment is placed in the well. These alterations may require changing the type of well head to one with multiple access ports through the top. WECO has been contacted about possibly gaining better access to the well. Access to this well is currently very difficult. Additional inquiries will be made to determine acceptable options to obtain water level measurements".*
>
> *WECO will be contacted about possibly gaining better access to the well.*

MDEQ Subcontractor Comment 23. Section 6.0. Page 6-2. Bullet 9. Please provide further information on what PPLM means by possibly altering access to the well.

Response:As constructed, the well cannot be accessed without removing the sanitary seal and possibly damaging the well head and equipment near the well head. The intent of well head alterations would be to allow each access for water level measurements while eliminating the possibility of causing operational problems that could occur if water gaging equipment is placed in the well. These alterations may require changing the type of well head to one with multiple access ports through the top.

WECO will be contacted about possibly gaining better access to the well.

MDEQ Subcontractor Comment 24. Section 6.0. Page 6-3. Bullet 1. Please provide further information on the type of flow meters PPLM plans to install.

Response: Multiple types of flow meters may have applicability at the site. Plans to install such meters are currently not finalized.

However, meters will be chosen to reduce operation and maintenance that is associated with scaling problems often associated with the wells.

In addition, wells will be selected for flow monitoring which have not had a history of scaling or only minor scaling issues.

Wells that have shown a history of scaling problems will continue to be gauged for flow using volumetric measurements at the well head.

Comment:

15. Twentieth bullet

DEQ requests that PPLM clarify what "evaluate" signifies. If PPLM intends to acquire new data concerning permeability of the ponds, DEQ requests that a brief description of the measurement procedures (in-situ or laboratory) be added to the bulleted item. If the intent of PPLM is to perform new calculations of seepage by adjusting permeability values, DEQ requests that PPLM provide a description of how the new calculations differ from the calculations described in the site report. The requests by DEQ are the response to Comment #25 by the contractor.

If the recommendation list in Section 6.0 is generated from the data gaps listed in Section 5.0, DEQ cannot find a data gap that corresponds to this recommendation (Twentieth Bullet).

Response: Paragraph 1: An evaluation of water quality means that water quality in capture wells and wells near capture wells should be reviewed for quality. Trends and quality will provide an indication if water quality is improving and possibly reaching a point that some or all of the capture wells in a particular system can be considered for shutdown. The evaluation will include inspection of long term trends, if available and comparisons to background screening levels which are under review as of October 2014. There is not intent at this time to perform new seepage calculations by adjusting permeability data. Decisions to shutdown capture wells should be based on actual data and not computed or simulated information, although these typees of information may be helpful in completing a detailed evaluation. Additional text has not been added to the report regarding this topic.

Response: Paragraph 2: This is not considered a data gap but a suggestion to continue to evaluate trends and quality at capture systems.

MDEQ Subcontractor Comment 25. Section 6.0. Page 6-3. Bullet 3. DEQ agrees that the permeability of the Plant Site pond liners need to be better evaluated so that a more accurate estimate of seepage rates can be made.

Response:

Clay lined ponds – calculated values for clay lined ponds were based on initial estimates of permeability. Additional permeability data specific to individual ponds would aid in either confirming existing values used in the calculations or revising the parameters used in the calculations if new data indicate differences from the initial estimates.

Adjustments have been made to seepage calculations to allow for incidental seepage that could potentially result from installation or subsequent liner damage. Based on existing evidence, it appears that calculated seepage from synthetically lined ponds are reasonable.

Comment:

16. Twenty-first bullet:

DEQ suggests that the fourth sentence be changed to read "With respect to the construction of future ponds, or alteration of existing ponds, PPL should consider the use of liners that allow capture of seepage water if there are liner leaks or excessive seepage occurs."

With respect to the fourth sentence, DEQ requests that PPLM specify what is meant by "excessive seepage". DEQ requests that PPLM be more specific concerning the liner construction. DEQ requests that PPLM propose that any new liners will consist of at least one layer of modern geomembrane material (e.g. engineered high density polyethylene) with a drain system underneath the liner or better yet, double geomembrane liners with drain systems between the liners and under the bottom liner.

In different locations in the Plant Site Report, PPLM uses the term "water management" to mean different things. Please explain in the last sentence that water management, in this case, is related to the retention and storage of high-quality precipitation and runoff in impacted ponds with the purpose of diluting any contaminated water that leaks into the ground.

DEQ requests that in Section 5.0, PPLM add a new bullet item about the lack of information in the ponds below the surface, near and at the liners, and below the liners.

Response: Paragraph 1: The word "the" has been added to the text so the sentence corresponds with MDEQ requested wording change.

Response: Paragraph 2: Excessive seepage is seepage that can be detected and has potential impacts to the groundwater or nearby surface water systems, issues to the surface, or creates wet seepage areas outside of the ponds.

Response: Paragraph 3: Water management is a term that applies to many aspects of plant operation. Figure 2-2 shows a diagram of process water routing. The purpose primary purpose of placing the water in these areas is an attempt to create a mounding affect to help control flow of upgradient water towards the west. A secondary effect of placing water in these areas is to affect the quality of groundwater under or directly downgradient of the ponds.

Response: Paragraph 4: This comment was previously requested and addressed under Section 5, comment number 9.

Comment:

G. **Section 7.0 References**

Please include reference to sources that document the origin of the Giroud equation for seepage through synthetic liners.

Please include references to the regional geology of the northern Powder River Basin. Please include references to the formation and characteristics of the Tongue River Member of the Fort Union Formation.

Please include the references to the EPA guidance manuals and documents referenced in the remarks concerning Section 3.4.2 and the determination of the background screening levels for the indicator parameters.

Response: Additional Giroud references have been added.

Multiple references relating to the Fort Union Fm. geology have been added.

Comments noted. However, the document containing the EPA reference for BSL calculations is included in the referenced document, which has been included as an appendix to the revised Plant Site Report.

Comment:
III. Figure Revisions

1. **Figure 1-1**

   In the fourth paragraph of Section 1.0 page 1-1, please reference Figure 1-1 as showing the Plant Site Area defined in the AOC. DEQ requests that PPLM clarify in Section 1.0 that the current and future activities described in the AOC (site characterization, identification of contaminants of interest, establishment of cleanup criteria, risk assessment evaluation of remediation alternatives, remedial design, and implementation of selected remediation actions) all occur inside the boundaries of the Plant Site Area.

Response: Text has been added to Section 1.0 as requested.

2. **Figure 2-1**

   DEQ requests further description of the features on the figure.

   Please correct the spelling of the word "Return" in the label 22" HDPE Return Line from 3 & 4 EHP Clearwell. The word is currently misspelled.

In the northeast corner of the figure, please label the two coal piles located due east of Units 3 & 4 and immediately north of the 16" fly ash slurry line to the 3 & 4 EHP. North of the slurry line there are three unnamed ponds; please label these ponds.

DEQ requests clarification of the identity of the pond immediately south of the fly ash slurry line to the 3 & 4 EHP in the northeast corner of the Plant Site Area. The lettering "LINE FROM" (referring to the 22" return line to the 3 & 4 EHP Clearwell) is superimposed over the pond. If this pond is part of the Units 3 & 4 Bottom Ash Pond Area, please clarify the identification.

DEQ requests that the East Fork of Armells Creek be identified. DEQ requests the Surge Pond (Castle Rock Lake) be identified.

Response: Figure 2-1 Second sentence comment noted.

Response Figure 2-1 third comment – The features referenced have been identified to the extent possible. The exact identity of the "three unnamed ponds" north of the slurry line is unknown. It is believed that these are natural depressions on WECO property or are possibly sediment traps on WECO property and have been labled as the latter.

Response Figure 2-1 Fourth Comment – The pond is the Units 3&4 Bottom Ash Pond clearwell. Text on the figure has been moved to the west so it does not overlap the ponds.

Response Figure 2-1 Fifth Comment – noted and done.

3. **Figure 3-1 (Cross-section)**

Three of the shallow units have the same color (Spoil, Rosebud, and Fill). DEQ requests that the three units be identified by different color.

Fill is not described in the list of geological units in the Plant Site Area on pages 3-24 and 3-25. DEQ requests that either "fill" be fully described on the list or that the area described as fill on the figure be given another name on the list.

Clinker is extensively described in the list of geological units but is not shown on the figure. DEQ requests that if present on the cross-section, the clinker unit be added to the cross-section. If clinker is not present on the cross-section, DEQ requests that PPLM explain in the text of Section 3.4.1 that 1) clinker is not present on the cross-section and 2) where in the Plant Site Area clinker is found.

The alluvial and colluvial units are described in Section 3.4.1 as complex assemblages of different sized sediment. Presumably the western end of the cross-

section (Wells 82A and 80D) is covered by the alluvial unit. The 82A well log describes a surface layer of 10 feet of clay over an 8-foot layer of silt over a 13-foot layer of gravel. The 80D well log describes a surface layer of 10 feet of clay over an 8.5-foot layer of silty clay over a 13.5-foot layer of sandy gravel. DEQ requests that the western end of the cross-section in Figure 3-1 be modified to represent a more complex fining-upward sequence.

The transition from alluvium to colluvium probably cannot be clearly distinguished. Assuming that the gravel unit in the figure was probably only deposited by water, evidence for alluvial materials extends eastward from wells 76A (3.5-foot layer of gravel) to 31 M(no gravel layer) to AB-11S (a 0.75-foot layer of gravel and a 1.5 foot-layer of clay and gravel) to AB-14S (0.5-foot layer of gravel). DEQ requests that PPLM summarize in Section 3.4.1 the complexities of deposition and formation of the alluvial formations, including lateral migration and vertical deposition of material from the ancestral East Fork Armells Creek. DEQ requests that PPLM explain in Section 3.4.1 that the combination of stream processes and colluvial processes results in complex sediment units. DEQ requests that PPLM explain in Section 3.4.1 that the sediment units in the alluvium and colluvium not on the cross-section are likely to be different in thickness, layering, structure, and physical characteristics than what is represented on the cross-section.

Response: Figure 3-1 first comment – A hatch pattern was added so the three units are easily disnguishable.

Response: Figure 3-1 second comment – A description of fill has been added to the site hydrogeology section.

Response: Figure 3-1 third comment – The following text has been added to the hydrogeology section of the report. "Clinker is generally not present on the main Plant Site except at the northwest edge of the site, where it is dry. Clinker has occasionally been logged in drill hole loges but its actual occurrence at these locations is suspect. For these reasons, clinker is not shown on the cross section in Figure 3-1. "

Response: Figure 3-1 fourth comment – Text has been added to the upper layer of alluvium at the western edge of the cross section. It is acknowldeged that the overall depositional environment resulted in a fining upward sequence with basal gravels and progressively finer sediments at shallower depths. Althought the overall depositional environment indicates fining upward, there are lateral variations that make illustration of the sequences in two dimension difficult. Within each of the individual portions of the unit fining upward characteristics may be found. For this reason, the clay and silt, silty clay, clayey silt, sandy silt, sandy silty clay, and other combinations of poorly sorted sediments have not been broken out in great detail. Rather the label for the shallow alluvium has been changed to read, clay, silty clay, and sandy clay. The *important factor to note is that the depositional regime for the alluvium changed from a relatively high energy system when the gravels were deposited to a lower energy system as finer sediments were deposited.*

Response: Figure 3-1 fifth comment – The text in the hydrogeology section of the report has been revised to include more discussion of the depositional conditions for alluvium and how it relates to colluvium.

4. **Figures 3-2 to 3-9**

   Similarly to the well symbols in Figure 3-10, DEQ requests that the well names and well symbols of capture wells be colored. Please use a color that can be easily distinguished from the colored isocontours lines in the figures and the names and symbols of the groundwater monitoring wells. Please note in the figure legend the color change.

   DEQ requests that in Section 3.4.2 PPLM carefully define what are all of the "shallow units". Figures 3-2, 3-4, and 3-6 show the spatial distribution of background screening levels in the "shallow units". Please note that further comments concerning these figures are contained in the comments for Section 3.4.2.

   Either on Figures 3-2, 3-3, 3-4, 3-5, 3-6, and 3-7 or in the text of Section 3.4.2, please describe how the measurements of the indicator parameters in the capture wells are accomplished. Please describe if the sampling occurs while the well pumps are on or during a period when the well pumps are turned off. Please indicate whether the values shown on the figures represent conditions during active capture or not.

   On Figures 3-8 and 3-9, many of the capture wells are surrounded by closed contours indicating depressions in the potentiometric surface. Either on Figures 3-8 and 3-9 or in the text of Section 3.4.2, please describe how the groundwater elevation is measured. Please explicitly describe if the measurement occurs while the well pumps are turned on or during a period when the wells are turned off. Please indicate whether the values shown on the figures represent conditions during active capture or not. If the measurements were made while the pumps were on, please indicate if the values of elevations were corrected for well head loss.

   DEQ has requested that the author of the groundwater model report compare potentiometric surfaces generated from observations (such as Figures 3-8 and 3-9

of the Plant Site Report) with potentiometric maps in the 2012 groundwater model report including: Figure 3 (Potentiometric Surface Map for Shallow Groundwater, April-July 2010); Figures 29, 30, 31, and 32 (2001-2003 Simulated Layers 1-4; Figures 44, 45, 46, and 47 (2010 Simulated Layers 1-4). DEQ acknowledges that comparison of figures from the two reports is made more complicated by the different purposes of the reports. In order to better enable the comparison, DEQ requests that PPLM summarize in Section 3.4.2 the methodology used to construct Figures 3-8 and 3-9 including selection of well data and date range of measurement, computer software (if any), and expert judgments made in contouring potentiometric lines , particularly near capture wells.

DEQ requests that PPLM explain why maps of potentiometric surfaces in the Tongue River Member of the Fort Union Formation (Interburden and Sub McKay) were not included in the figures.

Response: Figures 3-2 to 3-9 comment 1. Symbols for capture wells and their lables are now different colors. Note, however, that capture wells that have groundwater with parameters that exceed BSL's are in red. Note also, that the symbol and size for capture wells are different from regular monitoring wells making identification easy.

Response: Figures 3-2 to 3-9 comment 2. Noted and addressed in comments for section 3.4.2.

Response: Figures 3-2 to 3-9 comment 3. Noted and addressed in comments for section 3.4.2. Text was added to Section 3.3.3 (original section 3.4.2). Samples are collected when the pumps are operating.

Response: Figures 3-2 to 3-9 comment 4. The text in Section 3.3.3 (original section 3.4.2) has been revised to include how the water level elevations are obtained. Groundwater elevations are calculated by subtracting the measured depth to water from the measuring point elevation. No correction is made for well loss. Well loss corrections would be time consuming and highly variable depending on the age of the well, condition of the well screen, condition of the formation around the well, condition of the filter pack, and pumping rates. Water levls are measured in pumping wells and it is noted if the pump is on or off at the time of the measurement.

Response: Figures 3-2 to 3-9 comment 5. Noted

Response: Figures 3-2 to 3-9 comment 6. – Interburden water levels are typically included in the shallow interval since there is generally direct hydraulic communication. Sub-McKay maps were excluded from the report submitted in December 2012 due to a lack of data to construct a meaningful map. A potentiometric map for the sub-McKay strata is included in the revised report.

5. **Figure 3-10 (Map Capture/Monitoring Wells)**

   Please note in the figure legend that the names of the capture wells are in blue text.

   DEQ requests that PPLM distinguish on the figure between wells that are currently sampled once or twice a year and wells that are sampled either less frequently or not sampled at all. Please explain the identification scheme in the figure legend.

   DEQ requests that PPLM explain details concerning the wells on this figure. DEQ requests that PPLM explain the well code concerning the unit of well completion on this figure (e.g. A for alluvial, M for McKay coal). DEQ requests that PPLM explain the purpose, general depth of completion, and unit of completion for the following wells and piezometers without the code: the 800 series; the SRP series; the B series; the PS series (only PS-2); the P series; the L series; the OT wells. Please note on the figure that the same descriptions apply to the wells indicated on Figures 3-2 to 3-9.

Response: Figure 3-10 Comment 1. Noted. The different colors were intended to distinguish the capture wells from monitoring wells. Note that symbols for the capture wells are also different from those of monitoring wells.

Response: Figure 3-10 Comment 2. The wells have not been coded as requested since it would clutter the figure since multiple colors and symbols are already used to distinguish pumping from non-pumping wells as indicated in Comment 1. Appendix E contains a copy of the water resources monitoring plan for the Colstrip SES. The document provides a monitoring schedule for wells that were installed at the time of its publication. Other wells have been installed since that time and have been sampled at least once, and in most cases, twice a year.

Response: Figure 3-10 Comment 3. Noted and noted on figures.

6. **Figures 3-11 to 3-15 (Graphs of indicator parameter trends for selected wells).**

   For all figures, DEQ requests that PPLM add the units to each of the graphs. For all figures, DEQ requests that PPLM designate in each of the right-hand graphs (graphs of boron and chloride versus date) which constituent is represented by concentrations plotted on the left-hand vertical axis and which constituent is represented by concentrations plotted on the right-hand vertical axis.

   Please indicate on each figure which wells are monitoring wells or capture wells. For the capture wells, please note the date of conversion from monitoring to

capture on the time axes. Please indicate the background screening levels for the indicator parameters on the graphs using horizontal distinctly colored horizontal lines.

Please indicate on the figures the wells on each figure that are spatially associated with one another including:

a. **Wells that are believed to be on common groundwater flow paths (up gradient to down gradient)**
b. **Wells that are adjacent to sources of groundwater impact (e.g. current or former ponds)**
c. **Wells that are in proximity (up to 300 feet) to other wells**

Response: Figure 3-11 to 3-15 - Comment 1. Noted and completed

Response: Figure 3-11 to 3-15 - Comment 2. Noted and completed.

Response: Figure 3-11 to 3-15 - Comment 3. (a) Groundwater flow arrows have been added to potentiometric maps as request by MDEQ. These flow lines provide an indication of the direction of groundwater flow. Wells are shown on these maps. By examining the potentiometric map and the groundwater flow paths the commonality of the wells can be estimated.

(b)(c)- All of the wells are in the vicinity of groundwater impacts, although not all are impacted. The majority of wells are in proximity (within 300) to many other wells. Examination of the well location map provides an indication of the wells shown on the figures to other wells.

In Figure 3-11, please put the date ranges on the time axes when the mitigation measures involving changes to pond management occurred, including pond abandonment, changes in pond operation, and pond relining for the Units 3 & 4 Wash Tray Pond or the Units 1 & 2 Cooling Tower Blowdown Ponds occurred.

Response: Lables have been added for ponds that are pertinent to a particular well.

In Figure 3-12, please put the date ranges on the time axes when the mitigation measures involving pond relining and redesign occurred.

Response: Lables have been added for ponds that are pertinent to a particular well.

In Figure 3-13, please put the date ranges on the time axes when the mitigation measures involving removal of the Brine Ponds occurred.

Response: Lables have been added for ponds that are pertinent to a particular well.

In Figure 3-14, please put the date ranges on the time axes when the mitigation measures involving changes to the Units 1 & 2 A/B Flyash Ponds occurred. Please switch the order of the graphs for Well 109A.

Response: Lables have been added for ponds that are pertinent to a particular well.

In Figure 3-15, assuming that the Units 1-4 Sediment Retention Pond is within the Northwest subarea (Section 3.6.5), please put the date ranges on the time axes when the mitigation measures involving relining the pond occurred.

Response: Lables have been added for ponds that are pertinent to a particular well.

Comment:

IV. Table Revisions

The comments in this section discuss the tables using the original numbering scheme.

a. **Table 2-1**

DEQ assumes that "total capacity" means the total design capacity and that "surface area" means the area defined by the top of the sidewalls. Please define the terms total capacity and surface area in a footnote below the table. DEQ requests that the total capacity also be calculated in cubic feet and added to the table. DEQ requests that the surface area be calculated in square feet and added to the table.

DEQ requests that add a column be added with the current filled volume as of September 2014 for each pond.

DEQ requests that the term "plant bottom ash system" or "bottom ash system" be defined. These terms are found in the Comments section for the Units 1 & 2 Bottom Ash Pond w/ Clearwell, Units 3 & 4 North Plant Area Drain Pond, and Units 3 & 4 Bottom Ash Pond w/ Clearwell. Similarly DEQ requests that the term "circulating water system" (Comments section of Units 3 & 4 North Plant Area Drain Pond) be defined. Because of the complexities of these systems, DEQ suggests that these terms be defined in a general discussion of the circulation of water and water-suspended ash within the Plant Site Area in Section 2.1.

DEQ requests that PPLM document all important construction events and changes to the ponds and the date or date range of the changes in the Comments section of the table. In particular, please add the dates that the Units 1 & 2

Cooling Tower Blowdown Pond (Pond C) North and South Ponds, Units 3 & 4 Auxiliary Scrubber Drain Pond, Units 3 & 4 North Plant Drain Pond, and the Units 1-4 North Plant Sediment Retention Pond were lined.

DEQ requests that at the end of the table in a footnote that PPLM list the projected dates at which ponds will fill with solid material. DEQ recognizes that some of the listed ponds are filled in and others are no longer receiving solid materials.

Response a. Table 2-1– First paragraph – Conversions have been added to the table. Footnotes have been added to the table. Note that the conversion to cubic feet from acre feet and from acres to square feet are both 43,560. Only the units change.

Response a. Table 2-1– Second Paragraph - A column has been added with this information.

Response a. Table 2-1– Third paragraph – Definitions were added to Section 2.1

Response a. Table 2-1– Fourth paragraph – The information is contained in Table 2-1.

Response a. Table 2-1– Fifth paragraph –Project fill dates are not currently available. Upcoming site management changes have made current prediction of these times difficult at best.

Comment:

b. **Table 2-2**

1. **DEQ requests that the naming convention of the ponds in Table 2-2 be consistent with the naming convention of the ponds in Table 2-1. As examples, DEQ requests that in Table 2-2 the names "1 & 2 B Pond Between Liner", "1 & 2 AB Pond", "North Plant Area Drain Pond", " 1 & 2 Cooling Tower", and "3 & 4 WTP" be changed respectively to "Units 1 & 2 Flyash Pond B Pond Between Liner(s)", "Units 1 & 2 Flyash Pond AB Pond", "Units 3 & 4 North Plant Area Drain Pond", "Units 1 & 2 Cooling Tower Blowdown Pond", and "Units 3 & 4 Wash Tray Pond". DEQ requests similar changes to the other pond names in Table 2-2.**

Response: Table 2-2 has been revised and is now identified as Table 2-3.

Comment:

2. **DEQ requests that pond site samples that are surface water samples should be explicitly labeled in the table. After the name of the pond data set of surface samples, please add the words "surface water samples". As of the date of these comments, DEQ assumes but is not certain that the only non-**

surface samples are for "1 & 2 B Pond Between Liner" and "1 & 2 Pond Underliner".

Response: Pond samples are surface water samples and labeling should not be necessary. Note, however, that metals are typically analyzed as dissolved, similar to most groundwater samples. It correct that the underliner samples and between liner samples possibly contain groundwater.

Comment:

3. **DEQ requests that the sources of water for each pond be clearly stated in Table 2-2. DEQ suggests that a statement concerning sources for each pond could be added below each pond name in the "Site" column. Please include both current sources contributing water to the ponds as wells as residual sources residing in or near the ponds that may still be impacting the pond water quality. An example of such a statement for the "3&4 WTP" could be that current water quality is affected by remnant fly ash from the wash tray cleaning process (pond input discontinued in 1995) and water from direct precipitation into the pond (assuming that there has been no storm water drained into the pond). An example statement for "1 & 2 Pond-A" could be that current water quality is affected by remnant fly ash from the scrubber cleaning process (pond input discontinued in May 2005) and water from both direct precipitation into the pond and storm water runoff.**

Response: The requested information has been added to the table. Note also that a process water flow diagram has been added as Figure 2-2 as per a different comment.

Comment:

4. **DEQ requests that the water contributions from sources to the Units Flyash Pond A and B Pond Clearwell be clearly stated in Table 2-2. The data set in Table 2-2 now labeled "1 & 2 Flyash A and B Pond Clearwell" represents water sampled before or on 4/21/2005. Presumably, water from both Pond A and Pond B were entering the Clearwell during this sampling period. Was the water from the SRP groundwater collection system also entering the Clearwell during this time period? DEQ requests that PPLM add a footnote to Table 2-2 describing what sources were contributing water to this clearwell from 1975 to 2005, prior to the relining of the Clearwell.**

Response: Date ranges for pond samples have been added to the original Table 2-2 and the Table renumbered as 2-3.

Water Sources for the AB Pond have been added to the table.

Comment:

5. **DEQ requests that PPLM add the following columns to Table 2-2: median concentration; number of samples; sample collection frequency or frequencies; date ranges during which sampling was performed; number of nondetects for each constituent; detection limit value or values for each constituent. If the sample collection frequency did change for a pond, please include the date ranges when each frequency was valid.**

   Listing the detection limit value or values for each constituent may be too extensive for Table 2.2. It is likely that some detection limit values have not changed much since the beginning of sampling and others have greatly changed. In the event that the requested detection limit documentation is extensive, DEQ requests that a separate table for the inorganic constituents (major/ minor cations and anions, and trace metals) listing the detection limit values and the data ranges of validity of these detection limits be developed and incorporated into Section 2.2.1.

Response: Table 2-2 (now Table 2-3) has been revised with the addition of median, # of samples, detect frequency, date ranges. Detection limits are variable and have not been added to the table. Please refer to Appendix C for reporting limits.

Comment:

6. **DEQ requests in Table 2-2 the unit of chemical concentration (mg/l) for all chemical data and the unit for specific conductance (micromhos per centimeter) be explicitly listed below the title of the table and before the body of the table containing the data.**

Response: This requested change has been made.

Comment:

7. **DEQ requests that PPLM explain in a footnote at the end of the table whether the reported pH and specific conductance values are from field measurements or laboratory measurements.**

Response: The reported pH and specific conductance values have been clearly identified as laboratory samples by adding (LAB) to the table behind text.

Comment:

8. **DEQ requests that PPLM describe in a footnote at the end of Table 2-2 how nondetects (concentrations below the detection limit) affect the statistics presented in the table. In particular, DEQ requests details concerning whether or not assumed values (often 50% or 100% of the detection limit value) of nondetects for a parameter are used to generate the currently listed parameter statistics (minimum value, maximum value, and mean value).**

Response: A footer has been added that includes reference to the statistics being calculated using a value of 100% the detection limit.

Comment:

9. **DEQ requests that PPLM thoroughly check all the parameter statistics for accuracy for all the ponds. A significant number of statistics for "North Plant Sediment Pond" are incorrect; the minimum value is greater than the maximum value, and the mean is larger than both the maximum and the minimum. Examples of this include: pH; SC; TDS; Total Hardness; Calcium (dissolved); Magnesium (dissolved); Sodium (dissolved); Potassium (dissolved); Total Alkalinity; Bicarbonate; Carbonate; Sulfate; Chloride; Fluoride; Bromide, Nitrate + Nitrite as N; Orthophosphate; Aluminum (dissolved); Boron (dissolved); Cadmium (dissolved); Copper (dissolved); Iron (dissolved); Manganese (dissolved); Nickel (dissolved); Selenium (dissolved); Vanadium (dissolved); Zinc (dissolved).**

Response: The formatting error that caused the above mentined inconsistencies has been addressed.

Comment:

10. **In Table 2-2, there are several occurrences for total chlorine concentration and total mercury concentration cited as "NA" for the maximum value, minimum value, and mean value. DEQ requests that an explanation for the use of this term be added as a footnote at the end of the table.**

Response: NA was identified in a footnote at the bottom of each page of Table 2-2(now Table 2-3) as Not Analyzed. This footnote will remain on the table.

Comment:

11. In Table 2-2, there are several occurrences for dissolved mercury concentration cited as less than 0.001 mg/l for the maximum value, minimum value, and mean value and total mercury concentration cited as less than 0.0001 mg/l for the maximum value, minimum value, and mean value. Potential reasons for the use of an upper bound value could include sampling issues or laboratory issues (e.g. limits of detection). DEQ requests that an explanation for the use of these values for mercury be added as a footnote at the end of the table.

Response: A footnote has been added to the table as requested. Variations in reporting limits may result in the inconsisties noted.

These requests by DEQ are the response to Comment #2 by the contractor, "HydroSolutions", hired by DEQ to evaluate the Plant Site Report.

Comment:

c. Table 3-1

Please update the table to include investigations/reports completed in 2013 and 2014 through September 2014.

Response: Noted and updated.

Comment:

d. Table 3-2

DEQ requests PPLM modify Table 3-2 to include more information about the capture systems. DEQ requests that PPLM add information concerning the depth of capture (the screened interval) and the screened geological unit to the descriptions of the capture wells. Please add estimates of yields (capture rates) to the descriptions of the capture wells. If capture has been terminated or interrupted since startup of capture, please indicate the dates.

DEQ requests PPLM also add information concerning the pond drains (1&2 B Pond Between Liner, 1&2 B Pond Underliner, 1&2 Bottom Ash Clearwell Underdrain) to the table. Please add the site ID, the location, the date of startup, the estimate of yield, and a comment concerning where the leachate is piped to. If capture has been terminated or interrupted since startup of capture, please indicate the dates.

DEQ requests that a footnote be added to the bottom of the second page of the table in which PPLM explains that some of the water collected from the Plant Area capture wells is sent to the Vibratory Shear Enhanced Process (VSEP) facility and is subsequently reused in the power plant.

Response: First and second comment Table 3-2: MDEQ requested an extensive amount of additional information regarding pumping rates in comments for Section 3.5.2, including approximate yields for the past 5 years. This information was added to Table 3-3(formerly Table 3-2). In an attempt to provide all the information requested by MDEQ in the comments regarding this table, Table 3-3 has been further revised to include the majority of information. Some information requested may have already been added to text of the revised report or provided in previous comments.

Wells that have been turned off periodically due to improving water quality are noted. However, the request to list interuptions in pumping since startup is not possible to include in the table, or as an appendix. Interuptions in pumping occur when pumps turn off, when pumps fail, when electrical feeds or equipment fails, and for many other reasons.

Response: Third comment Table 3-2: A footnote was added to the table as requested. Note that water from the VSEP is used in Colstrip SES operations following treatment. There should be a distinction that only the water that is captured that has seeped from the pond is "reused". It is not possible to capture only process water since a portion of the captured water is ambient groundwater.

May 30, 2013
Comment/Responses
PPL Montana Colstrip Steam Electric Station
Administrative Order on Consent Plant Site Report

I. PLANT SITE REPORT

General Comments

The Plant Site report appears to provide information that meets the majority of requirements set forth in the AOC. However, the accuracy of all data and reporting was not be cross checked against historic reports

Specific Comments

Comment 1. Section 2.2. There appears to be inconsistent terminology used in tables, figures, and text when describing the plant site features. Please revise and be consistent when describing features.

Response:

Facilities at the site are often referred to by different names. Some of this has resulted in slight changes in names. For example, the ponds currently named Units 1 & 2 A Pond and B Ponds were originally called the Flyash Ponds A and B. With the construction of Units 3&4 these ponds were referred to as the Units 1&2 AB Flyash Ponds, Units 1&2 Flyash Ponds, AB Flyash pond, or AB Ponds. The Units 1 &2 AB Flyash Pond was separated into two pond Units 1&2 A Pond and Units 1&2 B Pond and are no longer routinely used for flyash disposal. We understand that this, and other, apparent inconsistencies may be confusing to readers unfamiliar with the facility. Better definition of various facilities will be used in the future and/or more clearly defined.

A table (Comment #1 Response Table) showing the wastewater facility name and terms that are also used routinely at the site is attached. A similar table is also present as Attachment A of the Colstrip Wastewater AOC and contains a brief history of each wastewater facility.

Comment 2. Section 2.2.1. First sentence. All data used to calculate the maximum, minimum, and mean should be provided. Please describe how reported values less than detection limits were statistically handled. Please provide the sample collection frequency.

Response:

- *Data are provided in with annual reports in electronic format.*
- *The detection limit was used when a value was reported as non-detect.*
- *Ponds are typically sampled at least once every three years. In addition, pond water is periodically sampled and submitted for an extended list of parameters which includes both organic and inorganic parameters.*

Comment 3. Section 2.3. First Sentence. Please identify each pond listed on Table 2-1 that was used in the seepage estimates in the Plant Site Report. Please provide all input parameters for each pond used to calculate seepage, and the estimated results. Currently, there is insufficient information to review the calculations and results provided.

Response:

Ponds used in Seepage calculations
Units 1&2 Flyash Pond A, B, Bottom Ash Pond, Bottom Ash Pond Clearwell, Cooling Tower Blowdown Pond C (north and south).
Units 3&4 Auxiliary Scrubber Drain Pond, North Plant Area Drain Pond, Wash Tray Pond, Scrubber Drain Collection Pond (DC Pond),
Units 1-4 Sediment Retention Pond and North Plant Sediment Retention Pond

Input Parameters as listed in Section 2.3
Surface Area, Head, Liner permeability, thickness of liner. Additional data can be provided but are included in various previous reports, etc.

Comment 4 Section 2.3. Line 6. Given that the seepage rate calculations are head dependent, water levels from ponds where seepage was estimated should be actual water level elevation measurements and not assumed values.

Response:

Actual elevations were used where available. When not available, such as for the Units 3&4 Wash Tray pond, a conservative estimate of depth was used.

Comment 5 Section 2.3. Line 13. By using the average value, it appears that PPLM assumed a less conservative (lower permeability) value, which may not be the case. A sensitivity analysis should be completed where a range in permeability values is evaluated.

Response:

The permeability value used in the seepage calculation (0.515 feet per year) is more than an order of magnitude greater than the highest reported laboratory *permeability. Note that lab permeability from 0.01 to 0.05 feet per year was referenced.*

Comment 6. Section 2.3. Paragraph 2, Line 4. It is not clear how the pressure head value in the soil under all conditions can be assumed to be zero. If the soils were unsaturated, the head would be negative (suction). But if seepage or high water table had already saturated the soil, it would have some positive value. This generalized approach does not appear to be supported in the assumptions provided in Bouwer (1982) and used to calculate the seepage rate through the clay liner. Please provide additional information to support use of this assumption.

Response:

Highly negative soil-water pressure head would not exist beneath seeping operational clay-lined ponds, except possibly during a temporally narrow period of initial wetting. At steady state, soil-water pressure becomes less negative and seepage becomes dependent on head above the liner, liner thickness, and liner permeability. The effects of negative pore pressure are assumed to be minimal but are admittedly poorly parameterized by our current knowledge of the system. If soil-water pressure head as low as -100cm (~ -3.28 feet) were assigned to the calculations, keeping other parameters constant, the overall seepage estimate would increase by about 32% (from 60 gallons per minute (gpm) to 79 gpm).

Under saturated conditions, some positive pressure head would exist; however, positive pressure head in seepage equation 1 of Bouwer (1982) would result in a reduction of calculated seepage. The conceptual model is that of vertical unsaturated flow between the bottom of clay liner and the water table. Positive pressure head was omitted to keep estimates conservative.

Comment 7. Section 2.3. Paragraph 2, Line 8. Please provide all data, calculations, and results used in the seepage rate estimates for clay lined ponds.

Response:

Data and calculations are presented on the attached table for Comment 7, located near the end of this document.

Comment 8. Section 2.3. Paragraph 3, Line 2. While modern geotextile liners without flaws greatly limit seepage, they do not necessarily "virtually eliminate" seepage. This statement should be revised or provide additional data to support this claim.

Response:

This use of "virtually eliminates" versus "greatly limit" seepage appears to be a question of semantics and does not necessary affect the intent of the statement. We agree that a geotextile liner without flaws greatly limits seepage.

Comment 9. Section 3.1 Paragraph 1. Line 3 and Bullet 3. All process water related spills should be quantified and presented clearly in a table in the Plant Site Report.

Response:

Numerous reports and citations have been provided to DEQ summarizing this information. A summary table has been prepared and attached to this document that has tabulated process water related spills. Section 3-1 also contains a list of these events.

Comment 10. Section 3.1. Table 3-1. March 1996 reference. The text states that each sump extends to bedrock. However, fractured bedrock is not impermeable and allows for the movement of contaminants below the alluvium-bedrock interface. Please provide data that indicates that migration of contaminants into the bedrock is addressed.

Response:

Each sump is operated as a capture well. The base is completed at the bedrock interface. Groundwater capture is also occurring in wells completed in the bedrock units. In these areas, groundwater levels are lower than in the alluvium. Groundwater flow towards the bedrock wells is induced by pumping in these wells. Water potentially moving downward or laterally into the bedrock is captured by the wells completed in the deeper units.

Comment 11. Section 3.5.1. A table and figure summarizing PPLM Water Resources Monitoring Plan should be included in the Plant Site Report to aid in understanding the operational monitoring approach.

Response:

PPL Montana submitted its latest version (Revision 5) of Water Resources Monitoring Plan to DEQ on September 12, 2011.

Comment 13. Section 3.5.4 Paragraph 1, Line 3. The first sentence needs to be clarified.

Response:

The referenced sentence reads: "PPLM continues to improve best management practices, training, and facility upgrades to improve environmental conditions near *the Plant Site and to aid in groundwater mitigation efforts, and to help compounding existing or creating new problems in the future".*

The sentence had a typographical error and should read" The referenced sentence reads: "PPLM continues to improve best management practices, training, and facility upgrades to improve environmental conditions near the Plant Site, to aid in groundwater mitigation efforts, and to help reduce the potential of compounding existing problems or creating new problems in the future".

Comment 14. Section 3.6.1. Page 3-51. First Line. The text "groundwater from directions" is not clear. Please clarify.

Response:

This is a typographical error. From should read flow making the text read "groundwater flow directions".

Comment 15. Section 4.0. Comments regarding the groundwater model are provided in Section II.

Response:

Responses to comments regarding the groundwater flow model are addressed following specific comments under

Comment 16. Section 5.0. Bullet 2. The first sentence is not clear and appears to be a fragment. Please clarify.

Response:

This is a typographical error. The sentence should read: "Model simulations indicate incomplete groundwater capture".

Comment 17. Section 5.0. Bullet 3. Please provide water quality data for this capture well, if available.

Response:

Field conductivities are routinely collected from the well. SC of the discharge water is typically 4,900 to 5,000 µmhos. Laboratory data from the WECO well is available for the 2008-2012 is attached as Table Comment 17 Response WECO Well Water Quality Data.

Comment 18. Section 5.0. Page 5-2. Bullet 4. Given the statement that highly saline water can alter the clay liners, please provide DEQ with an indication of how reliable PPLM believes the seepage calculations are and what steps will be taking to verify hydraulic conductivity values.

Response:

PPL believes the calculated seepage rates are reasonable, if not conservative.

Comment 19. Section 6.0. Bullet 1 and Page 6-3, Bullet 2. The recommendation to consider periodic shutdown of groundwater capture wells showing improvement requires further information. Please provide what PPLM considers an "improvement". Also, please provide the sampling frequency and parameters that PPLM proposes to review prior to recommending any well for shut down.

***Response**:*

Groundwater quality that has declined below what is considered baseline levels and/or background screening levels established by statistical analysis previously conducted for the site. Long term water quality trends will be evaluated to verify that wells have returned to levels observed prior to initiating capture. These criteria will be further refined in the next phase of the AOC process concerning corrective action..

Capture wells are routinely monitored two to three times per month for operation, water levels, and pumping rate. Field specific conductance is measured monthly. In addition, water quality samples are collected and submitted for laboratory analysis twice a year. Samples submitted for laboratory analysis are analyzed for PPL's standard list of analytes. These data (field and laboratory) will be reviewed prior to shutting down any capture well. Any capture wells that are shut down will continue to be monitored for SC on a monthly basis and sampled for laboratory analysis twice a year. Pumping will be resumed if data indicate worsening water quality.

Comment 20. Section 6.0. Bullet 2. Please provide information regarding the frequency and schedule for water level monitoring at the site.

***Response**:*

Water levels are measured on a monthly frequency from a defined set of wells. Additionally, an expanded list is measured twice a year. Further, water levels are routinely monitored in groundwater pumping wells and select monitoring wells in *the vicinity of the capture wells. Several piezometers in the Units 1 and 2 A pond and B Pond area are monitored once every three years, at a minimum. Frequency for monitoring is defined in the Water Resources Monitoring Plan (PPL, September 2011). See Comment 11.*

Comment 21. Section 6.0. Page 6-2. Bullet 2. Given the complex and dynamic nature of this site, it appears appropriate that the water balance be continual refined and provided to DEQ for review on a periodic basis.

***Response**:*

Efforts are continuously being taken to reduce water inventories in the ponds. These data are available in spreadsheets maintained by PPL and can be provided on a periodic basis. The information provided gives an indication of the overall gain or losses from water managed in the process ponds.

However, a detailed water balance throughout all plant operations has not been conducted for numerous reasons, including difficulty in maintaining flow gages due to scaling, variations in evaporation rates, pipes without gages, variable precipitation, and other factors necessary for accurate water balance. As discussed above, the spreadsheets that are maintained likely provide the best basis for evaluating water losses and gains for the facility.

Comment 22. Section 6.0. Page 6-2. Bullet 7. It appears that the word "if" should be placed between capture well and well 106A in the fourth sentence.

***Response**: That is correct.*

Comment 23. Section 6.0. Page 6-2. Bullet 9. Please provide further information on what PPLM means by possibly altering access to the well.

***Response**:*

*As constructed, the well cannot be accessed without removing the sanitary seal and possibly damaging the well head and equipment near the well head. The intent of well head alterations would be to allow each access for water level measurements while eliminating the possibility of causing operational problems that could occur if water gaging equipment is placed in the well. These alterations may require changing the type of well head to one with multiple access ports through the top.***

WECO will be contacted about possibly gaining better access to the well.

Comment 24. Section 6.0. Page 6-3. Bullet 1. Please provide further information on the type of flow meters PPLM plans to install.

***Response**:*

Multiple types of flow meters may have applicability at the site. Plans to install such meters are currently not finalized.

However, meters will be chosen to reduce operation and maintenance that is associated with scaling problems often associated with the wells.

In addition, wells will be selected for flow monitoring which have not had a history of scaling or only minor scaling issues.

Wells that have shown a history of scaling problems will continue to be gauged for flow using volumetric measurements at the well head.

Comment 25. Section 6.0. Page 6-3. Bullet 3. DEQ agrees that the permeability of the Plant Site pond liners need to be better evaluated so that a more accurate estimate of seepage rates can be made.

***Response**:*

Clay lined ponds – calculated values for clay lined ponds were based on initial estimates of permeability. Additional permeability data specific to individual ponds would aid in either confirming existing values used in the calculations or revising the parameters used in the calculations if new data indicate differences from the initial estimates.

Adjustments have been made to seepage calculations to allow for incidental seepage that could potentially result from installation or subsequent liner damage. Based on existing evidence, it appears that calculated seepage from synthetically lined ponds are reasonable.

II. PLANT SITE GROUNDWATER MODEL DESIGN AND CALIBRATION

General Comments

In general, it appears that the model met the limited requirements identified in the AOC. The site is part of a very dynamic hydrogeologic and water balance system. However, the role for this model is not defined in the AOC. It is not clear if the model results will be used by PPLM to meet on-site compliance and capture requirements or if the model is solely to assist in predicting extent of contaminant migration for the purpose of groundwater monitoring. If groundwater modeling is required under the AOC to demonstrate compliance, then a more thorough review of the model is necessary.

Response:

The groundwater model is a tool to assist in evaluating hydrogeological conditions at the site including capture system effectiveness and potentially for fate and transport evaluations. In addition, the model could be used to evaluate potential other remedial options, including caps, liners, slurry walls, etc. The model is not intended to serve as an instrument of compliance.

Specific Comments

Comment 1. Section 2.1.1. It appears that the potentiometric maps used in the model were developed only from limited data during a four month period, April – July 2010. We would assume that water levels fluctuate seasonally at the site, particularly throughout these four months. Please justify why data collected during the months of August through March were not used to develop appropriate potentiometric or groundwater elevation contour maps.

Response:

The potentiometric map shown in the figures was just one snapshot in time (based mostly on May 2010 data) and was not the only potentiometric surface map used to develop the model. A map made using average head values for the all of 2010 is similar to the one shown in Figure 3 of the report in Appendix A.

Comment 2. Section 2.1.2. Please provide additional information on the source for the water that is causing an increasing trend in water levels in wells completed in spoils.

Response:

Western Energy has added water to their pond south of South Cooling Tower Blowdown Pond C and the pond for storing dust suppression water south of the former brine pond (see Figure 2-1, tree-lined area south of the "South Cooling Tower Blowdown Pond C, and labeled WECO Sediment Pond),. In addition seepage from the south side of the 3&4 Bottom Ash ponds may provide some recharge to the spoil.

Comment 3. Section 2.3. The text states that former D4 Brine Pond breached in 2005. Please provide the 1) location and characteristics of the leak, 2) flow, 3) duration, and 4) water quality.

Response:

The D4 Brine Pond is discussed in Section 3 of the 2004, 2005, 2006 update report (Hydrometrics, Inc. 2005).

Comment 4. Section 3.0. Please provide information regarding how much of the initial model was used in the redesign current version and how dependent on the earlier versions is the current model. Were changes in boundaries, layers and discretization reflected in the new model?

Response:

The current model was initially constructed using the layers and zone values from the older model. The model was changed substantially by expanding the domain, then adding additional layers, property zones and new boundaries bounding the model. Information from the earlier model was used to guide the design and parameterization of the new model. For instance, calibrated recharge rates for the various ponds that had been determined previously were carried over into the new model. All the calibration data sets used in the earlier model were again used as calibration data sets.

Comment 4. Section 3.1. Given the size of the site area, the model domain used in the site model appears small. Please provide justification for this limited sized model domain, the reasonableness of boundary conditions, and the permanence of the boundaries utilized. Which are natural and which depend on engineering controls or current conditions at the site?

Response:

We do not believe the model domain is small. The domain was moved back to natural hydraulic boundaries to avoid the possibility of boundary affects. Mass balance analyses were run to assure that the boundaries are far enough away to assure external boundaries do not affect simulated aquifer stresses the area of interest (Plant Site). External boundaries such as the Surge Pond and GHBs are all based on site specific data and area reasonable. Stream elevation estimates from the USGS map were adjusted based on survey data for two surface water stations survey monitoring stations on the along the creek.

Comment 5. Section 3.3. Pages 6-7. This appears to be a fairly complicated set of boundary conditions which all contribute to uncertainty in calibration and interpretation of the simulations. Paragraph 2, page 7 indicates that East Fork Armells Creek was simulated with the MODFLOW River Package and that surface water elevations were estimated from USGS topographic map. Considering that the Creek bisects the site and the stream elevations are critical to correct groundwater flow interpretations, we suggest that surveyed stream elevations be obtained and checked against existing estimates. If warranted, the model should be revised and re-ran.

Response:

We agree it is a complicated set of boundary conditions. There are many stresses to the aquifer operating. In addition to the two stations that were already surveyed and incorporated into the model, stream elevations from synoptic gaging stations will also be incorporated into the model during the next model update.

Comment 6. Section 4.1 Paragraph 1. The inherent limitation of calibrations is obtaining a "unique" calibration, and many combinations of parameters could result in the same calibration results. Please clarify the hierarchy of parameters that were adjusted in the calibration process. Why were average heads (2001 through 2003) utilized instead of one or more sets of synoptic measurements representing a steady state condition?

Response:

The model was calibrated to two separate steady state data sets and short- and long-term transient data sets, which provides sufficient verification of the model's ability to simulate flow under a variety of aquifer stresses. The first steady state calibration period was meant to characterize an average condition prior to addition of several capture system wells and the D-4 Brine pond breach.

Comment 7. Section 4.1.1. Page 10. Paragraph 2. The calibration results appear to be acceptable. Is the overall calculated residual mean of -0.33 feet for all wells, alluvial and bedrock, used in the model? Also, please provide the absolute mean residual. How does the calibration compare to the targets set out for this model, and how does the calibration compare to typical industry guidelines?

Response:

The calculated residual mean for all target wells is -0.33. The industry standard is that this value should be as close to zero as possible. The mean of the absolute value of residual is 1.89 feet, which means that the average difference between simulated and target head values is 1.89 feet. The residual standard deviation divided by this range is about 2.8%. Industry standards are that this value should be less than 10% and less than 5 percent for a well calibrated model.

Comment 8. Section 4.1.1. Page 11. Paragraph 2. Please provide field measurement data, if available, which were used to confirm the gain in stream flow in the East Fork of Armells Creek.

Response:

> *The specific data are provided in Hydrometrics (2010. PPL Montana, LLC East Fork Armells Creek 2010 Synoptic Run. July.) In addition, other seepage runs have been conducted in 1993, 1994, 1996, 2000, 2003, 2004, 2005, 2007, 2008, 2009, 2011 and 2012.*

Comment 9. Section 4.1.4. Page 13. Last Paragraph. While the residuals appear to be well balanced, the ±5 feet could be considered a relatively large range in a water table aquifer. Please clarify if the residuals were for water table wells, bedrock wells, or both. What was the residual of the water table wells only?

Response:

> *We do not agree that ±5 feet is a large range for a residual calibration goal for this type of model. This goal was for all target wells including alluvial, bedrock, and spoils wells. The model domain includes a complex layered sequence of the Fort Union Formation. Most head targets are matched within +/- 2 or 3 feet. The range of target head values in the model domain is about 83 feet. The residual standard deviation divided by this range is about 2.8% which is well within accepted standards.*

Comment 10. Section 4.1.4. Page 15. Paragraph 2. The match between a modeled steady state simulation and single synoptic field measurement appears to be reasonable. However, synoptic measurements will vary due to ambient hydrologic conditions and measurement error. Please clarify the number and location of seepage runs relied on for the modeling.

Response:

> *Synoptic flow gaging has been completed in 1993, 1994, 1996, 2000, 2003, 2004, 2005, 2007, 2008, 2009, 2010, 2011 and 2012. All data were reviewed in developing the model. In the 2001 to 2003 steady-state calibration, simulated stream fluxes were compared to 2003 synoptic flow values.*

Comment 11. Section 5.0. Paragraph 4. The results of reverse particle tracking suggest that elevated constituent concentrations reported from wells CA-19 and OT-7 did not originate from the plant site. However, it is not clear where the elevated constituents may have originated. Please provide further information as to the origin of the constituents.

Response:

> *The source of concentrations detected in CA-19A appears to be highly localized near the well head and the well may have been tampered with.*

Particle tracking results from model simulations suggest the source of constituents detected in samples from OT-7 is west of the well. However, another potential source could be related to a past pipeline spill that occurred southeast of OT-7 (See Table 3-1 Hydrometrics, November 1998). The likelihood of this spill and associated cleanup activities as a source is somewhat diminished because of the location and distance of this event from OT-7.

Comment 12. Section 6.0. The sensitivity analysis described in this section is somewhat limited. It is not clear that the variations used in the sensitivity analysis are sufficient to characterize the effect on the model water balance and capture analysis. Include sensitivity analysis of variables such as effective porosity that effect travel times and extreme recharge events that could affect excursions of contaminants. Report the effect of sensitivity analysis on the model water balance and groundwater contaminant capture efficiency. For example, how did the results of sensitivity analysis compare to the measured discharge of East Fork Armells Creek?

Response:

These sensitivity analyses will be carried out as part of the next update of the Plant Site Model.

Comment 13. Section 8.0. Paragraph 2. It appears evident from the text that the external boundaries used in the former model domain were viewed as a problem when evaluating the reliability of the earlier model. We agree this model represents improvements in this regard. However, we encourage an iterative process of field monitoring and model adjustment, including the three "uncaptured" areas identified on page 19, and any other relatively high permeability pathways.

Response:

This type of iterative process has been used since the early phases of modeling and will be continued in the future. The model will be adjusted in the future based upon further investigation and monitoring planned for the plant site area.

Comment #1 Response Table

Waste Water Facility	Also Known As
Units 1 & 2 Flyash Pond (no longer exists)	Units 1&2 Pond A; Units 1&2 Pond B (Fig 2-1); Units 1&2 A/B Fly Ash Pond Area (Fig 3-14, pg 3-45); Units 1&2 Fly Ash A/B ponds, A/B Pond, Units 1&2 A/B pond, Units 1&2 A/B Pond Clearwell (Table 3-1)l Units 1&2 A and B Ponds (pg 3-28)
Clearwell	Units 1&2 Flyash (and Fly Ash) Clearwell, Fly Ash Clearwell, (Table 3-1), currently being used as Units 1 & 2 Bottom Ash Clearwell
A side (west)	Units 1&2 Pond A (Fig 2-1); A pond, Units 1&2 A Pond (Table 3-1, pg 3-28, 3-34, 3-39, pg 5-2);Units 1&2 Fly Ash (and Flyash) Pond A (Table 3-1); 1&2 A Pond (pg 3-28); A Pond (pg 3-59)
B side (east)	Units 1&2 Pond B (Fig 2-1); Units 1&2 **B** Pond (Sec 2.2, pg 2-34, Table 3-1, pg 3-39, pg 5-1); Units 1&2 **"B"** Pond (pg 3-2); B pond (Table 3-1), Units 1&2 B Flyash Pond, Units 1&2 Flyash B Pond (Table 3-1); 1&2 B Pond (pg 3-55)
1&2 Scrubber Pipeline	Scrubber Drain Pipeline (pg 3-1)
Units 3&4 Wash Tray Pond	Wash Tray Pond (pg 3-2, Table 3-1)
Units 1 & 2 Bottom Ash Pond w/ Clearwell	Units 1&2 Bottom Ash Clear Well; Units 1&2 Bottom Ash Ponds; Former Units 1&2 Bottom Ash Ponds (Fig 2-1, pg 5-1); Units 1&2 Bottom Ash Clearwell (Sec 2.2, pg 3-39, pg 6-3); Bottom Ash Ponds, Units 1&2 Bottom Ash (Table 3-1); 1&2 Bottom Ash Clearwell (pg 3-45)
Units 1 & 2 Brine Waste Disposal Ponds	Former Brine Ponds, Former Brine Pond Area (Fig 2-1, pg 3-28, Section 3.6.3); Brine Pond Area (Fig 3-13); 1&2 Brine Disposal Ponds, Units 1&2 Brine Ponds; Colstrip Units 1&2 Brine Ponds, Brine Pond (Table 3-1, pg 6-2)
D1 - D3 ponds	D3 Brine Pond (pg 3-1, Table 3-1); D3 Pond Liner (pg 3-1); Brine Ponds D1-D3, Brine Pond D-3 (Table 3-1, pg 3-44); former D1-D3 ponds (pg 3-41)
D4 pond	D4 Brine Pond (Sec 2.2, pg 3-2, Table 3-1); D4 Sump (pg 3-2); Former D4 Brine Pond (pg 3-28, pg 3-46); Brine Pond D4 (pg 3-44); former D4 pond (pg 3-53)
Units 1 & 2 Cooling Tower Blowdown Pond (Pond C)	Units 1&2 Cooling Water Blowdown Pond Area (Fig 3-11); Cooling Tower Blowdown Pond (Sec 2.3); South Cooling Tower Blowdown Pond (pg 2-33, Table 3-1), Pond C (Table 3-1); Blowdown Pond C (Table 3-1); C Pond (pg 3-28, pg 3-47);
North pond	Cooling Tower Blowdown Pond (North and South Pond C) (page 3-49); Units 1&2 Cooling Tower Blowdown Pond C North (pg 3-49)
South pond	South Cooling Tower Blowdown Pond C (Fig 2-1, Table 3-1); Cooling Tower Blowdown Pond C South (pg 3-39)
Units 3 & 4 North Plant Area Drain Pond	North Plant Drain Pond (pg 3-1, pg 5-1); North Drain Pond Liner (pg 3-2); North Plant Area Drain Pond (pg 3-39); North Drain Pond (pg 3-47)
Units 3 & 4 Wash Tray Pond	Wash Tray Pond (pg 3-2, pg 3-49, Table 3-1)
Units 3 & 4 Auxiliary Scrubber Drain Pond (Duck Pond)	Auxiliary Scrubber Drain Pond (pg 2-34); Units 3&4 Auxiliary Scrubber Drain Collection Pond (pg 3-48)
Units 3 & 4 Scrubber Drain Collection Pond. (DC Pond)	Units 3&4 Drain Collection Pond (Fig 2-1); Scrubber Drain Pond; Drain Collection Pond (pg 3-1, Table 3-1); Drain collection pond (pg 3-47)
Units 3 & 4 Bottom Ash Pond w/ Clearwell	Units 3&4 Bottom Ash Pond Area (Fig 2-1 & Fig 3-12, Table 3-1, pg 3-51); Units 3&4 Bottom Ash Pond (pg 3-2, Table 3-1, pg 3-38, pg 5-1, pg 6-2); Units 3&4 Clearwell (Table 3-1); Units 3&4 Bottom Ash Clearwell (pg 3-39)
Units 3&4 Scrubber - EHP Pipeline	22" HDPE Return Line from 3&4 EHP Clearwell (Fig 2-1); Scrubber Drain Pipeline (pg 3-1); Units 3&4 scrubbers (pg 3-2)
Units 1 - 4 Sediment Retention Pond (Thompson Lake)	Sediment Retention Pond (Fig 2-1, pg 3-2, Table 3-1, pg 3-59); Sediment Retention Pond liner (pg 3-1, Table 3-1, pg 3-47); North Sediment Pond (pg 3-47)
Units 1 - 4 North Plant Sediment Retention Pond	North Plant Sediment Pond (Fig 2-1, pg 6-2); North Plant Sediment Retention Pond (page 2-33); North Plant Pond (pg 3-2); North Sediment Retention Pond Area (pg 5-2)
Unit 4 Cooling Tower Canal	Unit 4 Cooling Tower Canal Break (pg 3-1)

Comment #7 Response Table Colstrip Steam Electric Station Plant Site Process Ponds Seepage Estimation

Waste Water Facility	Total Capacity (acre-feet)	Surface Area (acres)	Years in-service	Pond Liner	Initial Seepage Estimate (gpm) from (Bechtel 1976)	Permeability of Liner (ft/day)	Thickness of Liner (feet - clay) (mil - synthetic)	Head on Liner (feet)	Seepage (gpm)	Notes on Seepage Estimate
Units 1 & 2 Flyash Pond	490	27	1975 - present	see below	13	--	--	--	--	Initial seepage estimate of 13 gpm (Bechtel, 1976) included seepage from the Clearwell, A pond, B pond, and the Units 1&2 Wash Tray Pond. Initial estimate based on original three-foot thick clay liners in each pond. Estimates of seepage for each of the currently operating cells and liner types are included below.
Clearwell	49	3	1975 - present	Clay originally, double-lined RFP with leachate collection system installed in 2006	--	--	--	--	--	This section of the pond was removed from scrubber service in May of 2005. In 2006, this area was double-lined with 45 mil RFP and a leachate collection system installed between the liners and under both liners. This pond is now the Units 1 & 2 Bottom Ash Clearwell. See seepage rate calculations below.
A Pond (west)	245	14	1975 - present	Clay	--	1.4×10^{-3}	3	13	**24**	This section of the pond was removed from scrubber service in May of 2005. It is currently being used as a clean water storage pond (stormwater runoff, etc). Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head in pond measured on 11/28/2012.
B Pond (east)	196	10	1975 - present	Clay originally, double-lined RFP with leachate collection system installed in 2004.	--	6×10^{-5}	45	36	**0.14**	This section of the pond was double-lined with 45 mil RFP and a leachate collection system between and beneath the liners in 2004. The leachate collection system beneath the liners is also beneath the groundwater table; and it captures approximately 35 gpm. The leachate collection system between liners is dry (Pers. comm., Mike Holzwarth, 2012). Seepage rate calculated based on formulae of Giroud (1997), using web-based calculator at: http://www.landfilldesign.com/design/calculators/composite_leakage.aspx .
Units 1&2 Wash Tray Pond	50	8	1975 - 1980	Clay	--	--	--	--	--	No seepage estimate; pond not in operation. Originally served as a scrubber pond for the wash tray loop. This pond was abandoned in 1980 when a separate loop for the scrubber wash tray was determined to be unnecessary. This area was converted to the 1&2 Bottom Ash Pond in 1988.
Units 1 & 2 Bottom Ash Pond w/Clearwell	24	4	1975 - present	Clay, new clearwell double-lined RFP with leachate collection installed in 2006	NA	--	--	--	--	Collection area for bottom ash and drain collection pit effluent. Clearwater flows into the clearwell section of this pond and is returned to the plant bottom ash system for re-use. In 1988, the bottom ash ponds were relocated to the area just north of the 1&2 Flyash Pond B side. In 2006, the 1&2 Flyash Pond Clearwell was double-lined with 45 mil RFP (with leachate collection between the liners and below both liners) and converted to the new 1&2 Bottom Ash Pond Clearwell. Seepage estimates for the clay-lined bottom ash pond and RFP-lined clearwell are presented below.
Units 1 & 2 Bottom Ash Pond	12	2	1975 - present	Clay	NA	1.4×10^{-3}	3	3	**1**	Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head in pond assumed to be 3 feet. Assumed three feet of clay liner.
Units 1 & 2 Bottom Ash Pond Clearwell	49	3	1975 - present	Clay originally, double-lined RFP with leachate collection system installed in 2006	--	4.9×10^{-6}	45	30	**0.033**	This section of the pond was removed from scrubber service in May of 2005. In 2006, this area was double-lined with 45 mil RFP and a leachate collection system installed between the liners and under both liners. Seepage rate calculated based on formulae of Giroud (1997), using web-based calculator at
Units 1 & 2 Brine Waste Disposal Ponds	60	4	1976 - 2005	Hypalon	NA	--	--	--	--	Disposal location for brine from Wastewater Concentrator (RCC). The Wastewater Concentrator is no longer in-service (removed in 2000), so these ponds no longer collect brine.
D1 - D3 ponds	30	2	D1 & D2 1976 - 1994, D3 1980 - 1994	Hypalon	--	--	--	--	--	In 1980-1981, a failure of the D3 Pond was identified and repaired. In 1985, the Brine Pond Collection system was installed to collect impacted groundwater. These ponds were closed in 1994. The solids were removed and stored in F cell of the 3&4 EHP. The liner was also removed. The depressions from these ponds were left to provide a clean water collection area for precipitation which would allow for clean water recharge into the area.
D4 pond	30	2	1984 - 2005	Hypalon, with a underdrain system	--	--	--	--	--	This pond has an Underdrain Collection system and is used as a excess water storage area. In November 2005, a problem was identified with the liner and the pond was drained and removed from service. In 2006, the pond was closed with solids stored within a lined section and capped with a 45 mil RFP. In 2007, a soil cover was placed over the liner cap and seeding completed.
Units 1 & 2 Cooling Tower Blowdown Pond (Pond C)	400	20.5	1978 - present	Clay	15	--	--	--	--	Initial seepage estimate of 15 gpm (Bechtel, 1976) included seepage from north and south ponds. Initial estimate based on original three-foot clay liners in each pond.
North pond	195	10	1978 - present	Clay	--	1.4×10^{-3}	3	5	**8**	Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head on liner measured on 11/28/2012.
South pond	205	10.5	1978 - present	Clay	--	1.4×10^{-3}	3	15	**20**	Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head on liner measured on 11/28/2012.
Units 3 & 4 Auxiliary Scrubber Drain Pond (Duck Pond)	0.51	0.23	1983 - present	Hypalon	NA	5.4×10^{-6}	unknown	3	**2.8×10^{-4}**	Miscellaneous scrubber building drains drain to this pond. Seepage rate calculated based on formulae of Giroud (1997), using web-based calculator at http://www.landfilldesign.com/design/calculators/composite_leakage.aspx . Head in pond assumed to be 3 feet. Pond recently removed from service and will be replaced with concrete lined tank.
Units 3 & 4 North Plant Area Drain Pond	4.5	1	1984 - present	Hypalon originally, now High Density Polyethylene (HDPE)	NA	5.4×10^{-6}	unknown	3	**1.22×10^{-3}**	Receives raw water pretreatment filter backwash, cooling tower overflow, and miscellaneous north plant drainage. Water from this pond is sent to the bottom ash system or the circulating water system. Seepage rate calculated based on formulae of Giroud (1997), using web-based calculator at http://www.landfilldesign.com/design/calculators/composite_leakage.aspx . Head in pond assumed to be 3 feet.
Units 3 & 4 Wash Tray Pond	85	8	1983 - 1995	Clay	NA	1.4×10^{-3}	3	1	**3**	Originally served as a scrubber pond for the wash tray loop. This pond was abandoned in 1995 when a separate loop for the scrubber wash tray was determined to be unnecessary. The pond remains, but is no longer utilized. Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head on liner assumed to be one foot, as some standing water almost always present in this pond.
Units 3 & 4 Scrubber Drain Collection Pond. (DC Pond)	72	6	1983 - 1999	Clay	NA	1.4×10^{-3}	0.25	1	**0 to 13**	Received miscellaneous scrubber plant drains, washdown, and scrubber slurry at times. In 1989, this pond was relined with 3" of clay and the east and south banks were shored up to address dredging and bank erosion issues. In 1999, this pond was abandoned and the scrubber drains/washdown was sent to the 3&4 EHP. The pond remains, but is no longer utilized, except to store runoff from the coal pile and surrounding area. Pond is typically dry but may contain approximately one foot of head following periods of heavy precipitation. Seepage ranges from 0 to 13 gpm based on head from zero to one foot and method of Bouwer (1982).
Units 3 & 4 Bottom Ash Pond w/ Clearwell	38.4	7.6	1983 - present	Clay	--	1.4×10^{-3}	3	1	**3**	Collection area for bottom ash and main plant sumps. Clearwater flows into the clearwell section of this pond and is returned to the plant bottom ash system for re-use. In 1991, the initial settlement cells of this pond were relined with clay and reshaped. In 1999, a groundwater collection system was installed in this area. In 2002 and 2003, this groundwater collection system was expanded.
Units 1 - 4 Sediment Retention Pond (Thompson Lake)	16	3.6	1975 - present	Originally Hypalon lined, then relined with High Density Polyethylene (HDPE) in 1989.	NA	5.4×10^{-6}	unknown	3	**4.4×10^{-3}**	Receives plant storm water drainage and occasional scrubber overflow or cooling tower basin overflow. This water is pumped to the 1&2 Flyash Pond A or B side, depending on quality. In 1989, this pond was relined with HDPE to address gas bubbles that were causing the original hypalon liner to rise and risk its integrity. Seepage rate calculated based on formulae of Giroud (1997), using web-based calculator at http://www.landfilldesign.com/design/calculators/composite_leakage.aspx . Head in pond assumed to be 3 feet.
Units 1 - 4 North Plant Sediment Retention Pond	4	0.6	1975 - present	Clay	--	1.4×10^{-3}	3	1	**0.3**	Receives surface drainage from north plant and warehouse areas. Seepage estimate based on Bouwer (1982). Permeability of clay liner from Bechtel (1976). Head in pond estimated at one foot.
									60	**Estimated cumulative seepage rate of all plant site ponds.**

Comment #9 Response Table			
Date	**Area**	**Estimated Amount Loss Gallons**	**Action**
1977	Bottom Ash Storage Pond Pipeline leak	Unknown	Unknown
1979	Possible pipeline break noted near well 13M	Unknown	Unknown
November 1980	D3 Brine Pond - A tear in the liner occurred due to ground subsidence	1 million gallons of brine water	Liner repaired
1983	D3 Pond Line - tears observed in liner	Unknown	Repaired
1983-1984	Scrubber Drain Pond -Pipeline leak that penetrated the embankment	Unknown	Unknown
February 1984	Scrubber Drain Pipeline	Unknown	leak repaired
September 1984	Scrubber Drain Pipeline	Unknown	leak repaired
1985	North Plant Drain Pond – Hypalon liner damaged during initial use	No indication of water losses	Liner repaired
1988	D3 Brine Pond – tears in liner above 3280 elevation	Unknown but potential water losses	Water levels managed below tears until liner could be repaired.
1988	Drain Collection Pond – liner breach	No estimate or verification of water losses	Liner repaired
1989	Units 1-4 Sediment Retention Pond – gas bubbles formed under liner	No losses of water confirmed	Repaired to reduce risk of hypalon liner failure
1989-1990	Unit 4 Cooling Tower – break in canal caused by frost damage	Unknown	Repaired
May 22, 1991	Stormwater ditch – water overflowed due to debris blockage	50,000	Cleaned ditch to allow better flow of water
June 25, 1991	Stormwater ditch -	Unknown	Cleaned ditch to allow better flow of water
1991	Units 3&4 Bottom Ash Ponds – ash noted below pond	Unknown	Repairs made
1992	Flyash Slurry Pipeline Spill	Unknown	Pipeline repaired
1992	Stormwater Ditch – overflow due to constriction	Unknown	Cleaned ditch to allow better flow of water
1992	D4 Sump Overflow	Unknown	Unknown
October 26, 1992	Units 3&4 Clear Water Return Pipeline – backhoe damage	10,000	Repaired pipeline
1993	Units 3 & 4 Wash Tray Pond – backhoe damage	10,000	Repaired pipeline
1994	D4 Sump Overflow	Unknown	Unknown
1997	North Plant Drain Pond Liner tear	Unknown	Repaired liner
September 18, 1998	Flyash scrubber slurry pipeline failure	80,000 with estimated half entering East Fork Armells Creek	Repair pipeline, eventually replaced pipeline, remediated soil and water in the area and creek
March 29, 2000	Clear Water Return Pipeline Failure	122,500 with estimated 9,000 gallons entering East Fork Armells Creek	Contained and repaired pipeline
March 22, 2002	Common Effluent Tank Area – Water/slurry spill	50,000	All contained on asphalt and within drainage ditches
June 6, 2002	Effluent Pipeline to Units 1 & 2 B Pond - Flyash scrubber slurry spill	5,000	Pipeline repaired
June 16, 2002	Units 3&4 Auxiliary Building	Unknown	Unknown
July 23, 2002	West of Units 3&4 scrubbers – flyash scrubber slurry	10,000	Contained spill, flushed into stormwater ditches which flow to Units 1-4 Sediment Retention Pond
November 2005	D4 Brine Pond – liner failure due to subsidence under the pond	Unknown	Pond taken out of service, remediation system installed.
November 15, 2005	North Plant Pond	300	Unknown

COMMENT 17 RESPONSE TABLE **WECO** WELL WATER QUALITY DATA UNITS: milligrams per liter unless noted					
SITE CODE	**WECO WELL**	**WECO WELL**	**WECO WELL**	**WECO WELL**	**WECO WELL**
SAMPLE DATE	**4/12/2008**	**4/22/2009**	**4/12/2010**	**4/26/2011**	**3/29/2012**
SAMPLE NUMBER	**08S-735**	**09S-342**	**10S-207H**	**11S-304H**	**12S-292H**
LAB NUMBER	**8041375013**	**9042566010**	**41268051**	**1042075015**	**2032476043**
SAMPLE TIME	**7:40**	**15:30**	**16:30**	**11:30**	**13:25**
TOTAL ALKALINITY AS CACO3	584	556	572	551	535
BROMIDE (BR)	NA	NA	<10	<10	4
BORON (B) DIS	1.5	1.3	1.4	1.3	1.3
CALCIUM (CA) DIS	438	452	458	438	461
CHLORIDE (CL)	106	92	90	91	91
CARBONATE AS CO3	<1	<4	<4	<4	<4
BICARBONATE (HCO3)	713	679	697	672	653
MERCURY (HG) DIS	NA	<0.001	NA	NA	NA
POTASSIUM (K) DIS	16	16	16	15	14
MAGNESIUM (MG) DIS	434	440	454	418	413
SODIUM (NA) DIS	322	310	337	334	322
PH	6.6	6.8	6.8	6.7	6.8
PH (FLD)	NA	NA	6.7	6.7	6.38
SC (UMHOS/CM AT 25 C)	5030	5170	5070	4490	4520
SC (UMHOS/CM AT 25 C) (FLD)	4960	NA	5270	5040	4980
SELENIUM (SE) DIS	<0.005	<0.005	<0.005	<0.005	<0.005
SULFATE (SO4)	2850	2850	3110	2920	2900
TDS (MEASURED AT 180 C)	4990	5100	4910	4760	4790
WATER TEMPERATURE (FLD)	NA	NA	12.7	13.5	19.3